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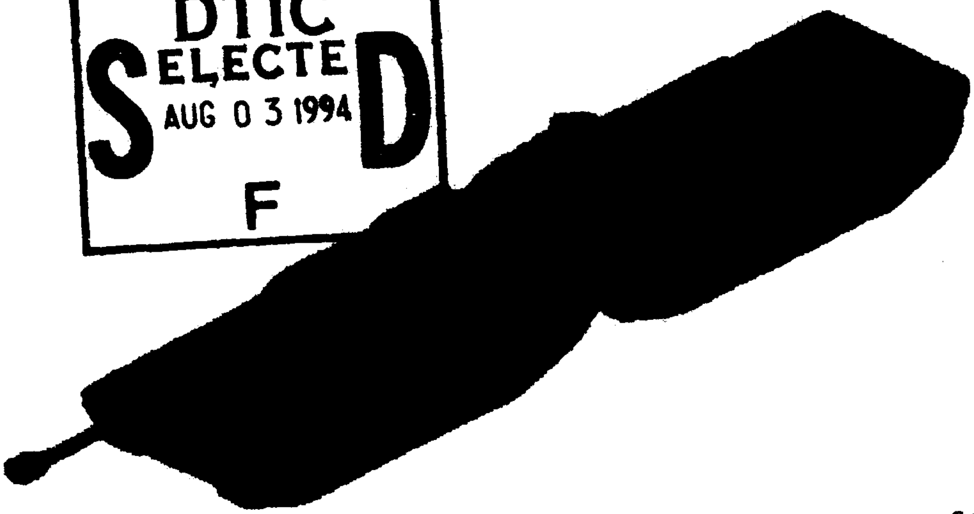
Advanced Distributed Simulation Technology

Advanced Field Artillery System (AFAS) / Future Armored Resupply Vehicle (FARV) Simulation Feasibility Analysis Study (FAS)



APPENDIX B

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APPENDIX B

FEASIBLE AREAS FOR DISTRIBUTED INTERACTIVE SIMULATION (DIS) EXPERIMENTATION

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APPENDIX B

20. FEASIBLE AREAS FOR DISTRIBUTED INTERACTIVE SIMULATION (DIS) EXPERIMENTATION. Providing the DEM/VAL contractor with an AFAS/FARV simulator suite is an attractive course of action for AFAS and FARV development. The simulator suite would permit the contractor to install prototype vehicle subsystems, operate the subsystems with surrogate or military crews in a combined arms environment, and exploit feedback mechanisms that provide measurable results on the subsystem's effectiveness. However, what areas are really suitable for DIS virtual experimentation and testing? What command, control, and communications (C^3) organizations and capabilities are needed to drive AFAS and FARV operations to support feasible experimentation and testing? What unmanned DIS entities in the form of Semi-Automated Forces (SAFOR) are required? These are the questions that this appendix addresses.

20.1 Assumptions. Listed below are the general assumptions made by FAS investigators as they conducted their analyses to determine areas suitable for DIS experimentation:

20.1.1 Contractor Interface. The DEM/VAL contractor will ensure that equipment installed in an AFAS or FARV simulator provides the required data to the simulation software architecture to support tests/experiments involving that equipment.

20.1.2 Battlefield Distributed Simulation-Developmental (BDS-D). The BDS-D virtual environment will be the simulation employed to support test objectives.

20.1.3 DIS Protocol. BDS-D will employ DIS Application Protocol Version

20.1.4 Requirements References. AFAS/FARV operational requirements, mission profiles, and specifications provide adequate information to derive simulator/simulation requirements for AFAS and FARV experimentation and testing.

20.1.5 Crew Manning. AFAS and FARV crew manning levels and Military Occupational Specialty (MOS) require further experimentation and analysis.

20.2 Determine Feasible Areas for DIS Virtual Experimentation.

20.2.1 Identification of Potential Areas for Experimentation. We examined the AFAS and FARV ORDs and system specifications and identified areas for experimentation that appeared to be supportable by data captured by a virtual DIS network. We identified 20 potential "DIS-able" areas. See Figure 20.2 below

Experiment Number	Potential Areas for Experimentation
1	Command, Control, and Communications
2	AFAS primary armament
3	Secondary armament
4	Decision aids: RSOP, SD, FMP, SUST, MM, ET
5	Sensor assets to support SD, i.e., FLIR, video, other
6	Countermeasure suite
7	Firing/resupply position parameters
8	Ammunition capacity
9	Docking operations
10	Ammunition transfer operations
11	LRP operations
12	Degraded operations
12	Degraded Operations
13	Crew size
14	Crew MOPP levels
15	Crew position intra/intervisibility
16	Crew environment
17	System safety
18	Vehicle mobility
19	Auxilliary power
20	Interoperability

Figure 20.2 Potential Areas for Experimentation

20.2.2 Analysis of Each Subject Area for Experimentation. We analyzed the requirements and specifications in each of the 20 experimental areas using the matrix in Figure 20.2.2. Based on the typical data currently captured by the BDS-D network, established DIS protocol data units (PDUs), and other designated data that a DIS network may capture if the DEM/VAL contractor feeds the data into the simulation software architecture, we determined the DIS-ability of each specification. If our initial assessment indicated that a specification was supportable by virtual DIS experimentation, we identified measures of performance or our intent for data collection. Next, we identified the data elements necessary to support experimentation for the specification under consideration. After we completed the matrix for an experimental area, we summarized the results of our analysis. We also discussed a sample experiment and the kind of information that experiment would yield. Finally, we addressed resource requirements to support testing for the experimental area under examination. We addressed the number and type of simulators needed, SAFOR requirements, and organizations and C^3 capabilities necessary to drive AFAS and FARV operations.

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment
Fire Mission Coordination. The C^3 subsystem shall be capable of accepting fire support coordination measures in the form of digital messages from the POC and shall automatically apply them to targets in the queued mission list and to the tactical and technical fire control solutions for routine fire requests. The C^3 subsystem will automatically warn the crew when a mission violates fire support coordination measures or unit boundaries defined by battlefield geometry.	AFAS simulator equipped with BCC, radios, modem, and crew station displays.	Detection and warning of violations of fire support coordination measures and friendly battlefield geometry.	**Identification of crew warning enunciators activated** **Target number violating control measures** **Location** Location of fire support coordination measure and battlefield geometry (maneuver control measure/unit location) Location of target in call for fire Location of AFAS howitzer Location of projectile trajectory (as plotted on x,y,z axes)
		Number of Fratricides	Location of fratricides by type if mission fired

Figure 20.2.2 DIS-Ability Matrix

20.3 Determine DIS Protocol Data Unit [PDU] Requirements. We examined the data elements contained in the DIS-ability matrixes, and identified DIS PDUs that would contain the data. Our principal reference for this effort was the Standard for Distributed Interactive Simulation Application Protocols, Version 2.0 (Fourth Draft), published by Institute for Simulation and Training. We formalized the linkage of the applicable PDUs with the data needed to support each measure of performance by adding a fifth column to our DIS-Ability Matrix. See Figure 20.3. During our analysis if data required to support a measure of performance was not contained in established PDUs, we called this out and provided recommendations for new enumeration values or an extension of DIS standards.

Subject of Experimentation/Testing. AFAS Command, Control, and Communications (C3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Fire Mission Coordination. The C^3 subsystem shall be capable of accepting fire support coordination measures in the form of digital messages from the POC and shall automatically apply them to targets in the queued mission list and to the tactical and technical fire control solutions for routine fire requests. The C^3 subsystem will automatically warn the crew when a mission violates fire support coordination measures or unit boundaries defined by battlefield geometry.	AFAS simulator equipped with BCC, radios, modem, and crew station displays.	Detection and warning of violations of fire support coordination measures and friendly battlefield geometry.	Identification of crew warning enunciators activated	Event Report PDU
			Target number violating control measures	Signal PDU; Event Report PDU
			Location	Recommend use of Event Report PDU to report control measure violations and fratricides based on examination of the data elements detailed under Location.
			Location of fire support coordination measure and battlefield geometry (maneuver control measure/unit location)	
			Location of target in call for fire	Signal PDU
			Location of AFAS howitzer	Entity State PDU
			Location of projectile trajectory (as plotted on x,y,z axes)	Entity State PDU
		Number of Fratricides	Location of fratricides by type if mission fired	Entity State PDU

Figure 20.3 DIS PDU Requirements

Subject of Experimentation/Testing. AFAS Command, Control, and Communications (C^3). The C^3 Subsystem provides for system level control of the AFAS. It provides AFAS with the capability to communicate and is comprised of the following elements: displays and controls for each crew member to include exterior vision devices; fire control computations and commands for the control of defensive armament pointing elements; tactical planning and execution support to the crew; internal and external communications equipment; and the capability to determine the system's present location in support of navigation.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
FARV Communications Interface. AFAS will have a communications interface with the FARV upon establishing a physical interface for ammunition and fuel transfer. A voice and data communications connection shall be automatically established between the docking systems during docking.	AFAS simulator equipped with BCC, radios, modem, intercom, and crew station displays	Digital messages are exchanged between FARV and AFAS by wire connection and are decipherable between nodes.	**Station identification**	
			Sender	Transmitter PDU
			Receiver	Receiver PDU
			Time (Voice communications have time stamp only)	
			Time message transmitted	Signal PDU
			Time message acknowledged by receiving node	Signal PDU
		Crew has serviceable voice communi- cation by wire connection with the FARV.	Time message processed by receiver	Event Report PDU
			Message type (message type pertains to digital messages only; voice messages tracked by time stamp)	Signal PDU
			Message content	
		Number of digital messages transmitted by type, receiver processing time, and message wait time.	Digital	Signal PDU
			Voice	Signal PDU
			Communications Medium	
			Wire	Signal PDU
			Items resupplied	
		Number of projectiles and amount of propellant, and fuel transferred and time consumed to complete the transfer by item.	Number of projectiles transferred by type	Event Report PDU
			Amount of propellant transferred	Event Report PDU
			Amount of Fuel Transferred	Event Report PDU
			Time required to complete resupply	
			Time to transfer all projectiles	Event Report PDU
			Time to transfer propellant	Event Report PDU
			Time to transfer fuel	Event Report PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Command, Control, and Communications (C^3) Digital Data Interface. The system shall be compatible and interactive with the Advanced Field Artillery Tactical Data System (AFATDS) using protocols specified in MIL-STD-188-200/VM. The system shall be interoperable with FARV to execute its intended mission.	AFAS simulator equipped with BCC, radios, modem, and crew station displays that are compatible with AFATDS.	Digital messages exchanged among POC, AFASs, and FARVs are decipherable among all nodes	**Station identification**	
			Sender	Transmitter Signal PDU
			Receiver	Receiver PDU
			Time	
			Time message transmitted	Signal PDU
		Percent of node and net use	Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiver	Event Report PDU
		Number of messages transmitted by node, net, and priority	Message wait time by node, net, and priority	Event Report PDU
			Message type and priority	Signal PDU
			Message content	Signal PDU
		Average queued message wait time by node, net, and priority	**Communications Medium**	
			Wire	Signal PDU
			Radio net ID	Signal PDU
		Average number of queued messages by node, net, and priority		
Rate of Fire. The C^3 Subsystem shall be capable of supporting rate of fire requirements.	Live fire	Rate of fire	**Time**	
	AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if AFAS C^3 Subsystem can perform within its allotted time frame to achieve required rates of fire.		Time Ballistic Computation Computer (BCC) acknowledges fire mission	Event Report or Message PDU NOTE: Start of the time interval may be at some point other than the time BCC acknowledges fire mission, such as the time which the BCC initiates execution of a preplanned fire mission.
			Time resupply completed	Resupply Received PDU
			Time first round fired	Fire PDU
			Time each subsequent round fired	NOTE: New enumeration values for several projectiles may be necessary (i.e. M110, M116, M712)

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Multiple Round Simultaneous Impact. The C^3 Subsystem shall provide ballistic solutions for MRSI missions.	Live fire	Total time between 1st and last round	**Time**	
	AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if AFAS C^3 Subsystem can meet MRSI requirements and achieve the desired effects on the target, within the allotted time frame.		Time each projectile fired	Detonation PDU
			Time of flight for each projectile fired	Event Report PDU
		MRSI range	Time first round impacts	Detonation PDU
			Time last round impacts	Detonation PDU
			Location	
		Outcome of MRSI engagement	Location of target in call for fire	Detonation PDU
			Location of firing AFAS	Fire PDU
			Effects on target	
			Vehicle and force identification	Entity State PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU
			Area illuminated	Suggest extension of DIS standards to allow representing illumination as an environmental entity, much like a smoke cloud is handled now.

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Responsiveness. The C^3 Subsystem shall be capable of supporting responsiveness requirements.	Live fire		**Time**	
	AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if C^3 Subsytem can respond within its allotted time frame to meet overall response times.	Mission response time for emplaced AFAS	Time fire mission acknowledged by BCC	Event Report or Message PDU
			Time BCC completes tactical fire direction	Event Report PDU
			Time BCC completes technical fire direction	Event Report PDU
			Time autoloader completes loading of first round	Event Report PDU
			Time first round fired	Fire PDU
		Mission response time for moving AFAS	Time vehicle stops in firing position	Entity State PDU
		Mission response time for AFAS in cold status	Time primary power applied to system (no auxiliary power running)	Event Report PDU
			Time all subsystems fully operational	Event Report PDU
		Mission response time for AFAS in warm status	Time primary power applied to system (auxiliary power is running)	Event ReportPDU
			Time all subsystems fully operational	Event ReportPDU
Range. The C^3 Subsystem shall be capable of providing ballistic solutions to support range requirements.	Live fire			
Bias and Precision. The C^3 Subsystem shall perform technical fire control functions required to achieve precision and bias requirements.	Live Fire			

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
System Survivability. The C^3 Subsystem shall provide support to the direct fire mission.	Live fire	Sensor activation	**Type of self defense sensor activated**	Event Report PDU
NOTE: *In addition to testing/experimenting* with direct fire sighting and fire control equipment, sensors in the self defense suite may be tied into the experiment.	Simulator that provides sensor warnings and a direct fire sighting and firing capability to gunner identical to that planned for AFAS.	Detection to firing time	**Time**	
			Time sensor activated alerting AFAS crew	Event Report PDU
			Time AFAS fires direct fire mission	Fire PDU
		Engagement range and point of impact	**Location**	
			Firing vehicle	Fire PDU
			Target vehicle	Detonation PDU
			Location of ordnance impact if target vehicle engaged but not hit.	Detonation PDU
		Type projectile fired	**Projectile type and number fired**	Fire and Detonation PDUs
		Outcome of direct fire engagements	**Effects on AFAS and target vehicle**	
			Vehicle and force identification	Detonation PDU
			Operational vehicles	Entity State PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Centralized Operations. The C^3 Subsystem shall provide support for centralized, decentralized and senior / subordinate operations. The system shall be capable of supporting standard, MRSI, and time-on-target missions. In centralized operations, the C^3 subsystem shall perform technical fire control to execute its assigned fire missions. Tactical fire control shall be performed by the POC or a higher level of command. NOTE: Implied in this specification is that each AFAS subsystem involved in the delivery of fire will complete its fire control function within the allotted time frame so that the overall response time and rate of fire requirements are achieved.	Live fire AFAS simulator equipped with BCC and radios capable of transmitting and receiving digital traffic.	Decipherable Messaging between POC and AFAS at both nodes. AFAS fire mission processing time by subsystem	**Sender** **Receiver** **Message Type** **Message Content** **Time** Time BCC acknowledges fire mission Time BCC completes technical fire direction Time Autoloader completes loading Time each round fired by type projectile	Transmitter PDU Receiver PDU Signal PDU Signal PDU Event Report PDU Event Report PDU Event Report PDU Fire PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Decentralized Operations. In decentralized operations, the C^3 subsystem shall, in addition to the technical fire control, perform the tactical fire control required to execute its assigned fire missions. The level of tactical fire control performed is limited to that which the POC normally performs for individual howitzers. Integral to the tactical fire control to be performed in decentralized operations, the C^3 subsystem shall comply with fire support coordination measures, automatically select the type and number of rounds based on the joint munitions effectiveness manuals in conjunction with the commander's criteria, determine the type of sheaf and associated aim points and method of delivery (serial or simultaneous impact) which the FATDS/AFATDS systems normally perform for individual howitzers.	Live fire Simulator equipped with BCC and radios capable of transmitting and receiving digital traffic. Objective is to determine if the C^3 Subsystem with the soldier-in-the-loop can perform within allotted time frames to achieve required response times, rates of fire and desired effects for serial and MRSI missions.	Messaging between POC and AFAS.	**Sender and receiver**	Transmitter and Receiver PDU
			Message Content	Signal PDU
		AFAS fire mission processing time by subsystem	**Time**	
			Time BCC acknowledges fire mission	Event Report PDU
			Time BCC completes technical fire direction	Event Report PDU
			Time BCC completes tactical fire direction	Event Report PDU
			Time Autoloader completes loading	Event Report PDU
			Time each round fired by type projectile	Fire PDU
		Detection and warning of violations of fire support coordination measures and friendly battlefield geometry.	**Crew warning enunciators activated**	Event Report PDU
			Location	
			Location of fire support coordination measures and battlefield geometry	Signal PDU
			Location of target in call for fire	Detonation PDU
			Location of AFAS howitzer	Fire PDU
			Location of projectile trajectory (x,y,z axes)	Entity State PDU
			Effects on Target	
		Outcome of indirect fire engagement	Vehicle and force identification	Detonation PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU
			Area illuminated	Suggest extension of DIS standards to allow representing illumination as an environmental entity, much like a smoke cloud is handled now.

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Fire Mission Preplanning. The C^3 subsystem shall be capable of storing and executing up to 30 targets.	Live fire AFAS Simulator with BCC and radios installed to enable crew to receive and transmit digital communications and process and store planned targets.	Number of stored planned targets. AFAS fire mission processing time by subsystem	Target number of each planned target in BCC	Event Report PDU
			Time	
			Time BCC acknowledges fire mission for planned target	Event Report PDU
			Time BCC completes technical fire direction	Event Report PDU
			Time BCC completes tactical fire direction	Event Report PDU
			Time Autoloader completes loading	Event Report PDU
			Time each round fired by type projectile	Fire PDU
Fire Mission Coordination. The C^3 subsystem shall be capable of accepting fire support coordination measures in the form of digital messages from the POC and shall automatically apply them to targets in the queued mission list and to the tactical and technical fire control solutions for routine fire requests. The C^3 subsystem will automatically warn the crew when a mission violates fire support coordination measures or unit boundaries defined by battlefield geometry.	AFAS simulator equipped with BCC, radios, modem, and crew station displays.	Detection and warning of violations of fire support coordination measures and friendly battlefield geometry.	Identification of crew warning enunciators activated	Event Report PDU
			Target number violating control measures	Event Report PDU
			Location	
			Location of fire support coordination measure and battlefield geometry (maneuver control measure/unit location)	Recommend use of Event Report PDU to report violations of control measures based on an examination of the data elements detailed under Location.
			Location of target in call for fire	
			Location of AFAS howitzer	
			Location of projectile trajectory (as plotted on x,y,z axes)	
Fire Support Display. The C^3 shall display friendly and enemy locations and boundaries graphically to the crew on request. The display of this information and the crew member(s) to which it is displayed shall be selectable by the chief of section (COS). To assist the crew in correlating this information to their areas of operation, this information shall be overlaid on a digital map display of the area.	AFAS simulator with installed crew station displays, radios and modems capable of running crew station software developed by the DEMVAL contractor.	Selectivity of graphical data displayed over map of area of operations.	Location	
			Location of AFAS	Entity State PDU
			Location of friendly units	Entity State PDU
			Location of enemy units	Entity State PDU
			Location of fire support coordination measures and battlefield geometry	Signal PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Final Protective Fire Mission (FPF). In addition to the 30 queued targets, the C^3 subsystem shall separately plan and store one final protective fire mission. This mission shall have the highest priority. The crew shall be notified immediately whenever a change in the AFAS's status results in its inability to support the mission. NOTE: Implied in this specification is that the BCC will identify the reason why the AFAS is no longer able to support the FPF mission so the crew or POC can reposition the howitzer or assign the mission to another howitzer.	AFAS simulator with BCC, radios, displays, and modem installed.	Identification of stored FPF target	**Target number of FPF**	Event Report PDU
		Crew notification of inability to support FPF	**Activation of crew enunciator indicating AFAS's inability to support the mission.**	Event Report PDU
		Reason unable to support FPF	**Range** Location of FPF AFAS howitzer location **Immediate and intervening crests** Location of projectile trajectory (on x,y,z axes) Location and altitude of immediate and intervening crests **Ammunition** Number of projectiles on board that are of the type needed to support the FPF	Recommend an Event Report PDU containing this data (range, immediate and intervening crests, and ammunition) be issued when the BCC determines that the AFAS is unable to support the FPF.
		Comparison of FPF "did hit" and "should hit" locations	**If FPF fired** Location of impacting ordnance Location of planned FPF Location and type of fratricdes	
Technical Fire Control. The C^3 subsystem shall perform battlefield geometry and ballistics computations to develop fire control commands for the primary armament subsystem. Technical fire control solutions shall include interior, exterior, and terminal ballistics determinations required to optimally execute assigned fire missions while minimizing its exposure and operating signature. Unless timely resupply of ammunition to support a mission is expected, technical fire control computations shall be based on the inventory of ammunition available on board the AFAS.	Live fire			

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Battlefield Geometry. The C^3 Subsystem shall be capable of determining range, vertical interval, direction and intermediate crest information. Trajectories shall clear all intermediate crests and other masks to firing in accordance with established commander's/mission criteria. Clearance distances shall be in accordance with applicable safety rules.	AFAS simulator with installed crew station displays, radios and modems capable of running crew station software developed by the DEMVAL contractor.	Planned and fired projectile trajectories clear intermediate crests and friendly battlefield geometry .	**Location**	
			Location of fire support coordination measures and battlefield geometry	Signal PDU
			Location of target in call for fire	Signal PDU
			Location of AFAS howitzer	Fire PDU
			Location of projectile trajectory (x,y,z axes)	Entity State PDU
			Location of intermediate crests and respective altitudes	Event Report PDU to indicate that an intermediate crest obstructs a projectile's trajectory.
			Location of fratricides by type	Entity State PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Self Location/Gun Pointing. The C^3 Subsystem shall have an independent self locating and gun pointing capability consistent with bias and precision requirements. Location shall be provided in terms of northing, easting and altitude in meters, using the conventions of the Universal Transverse Mercator (UTM) coordinate system. Gun pointing in azimuth and elevation shall be provided in terms of artillery mils. The C^3 subsystem shall be capable of accepting azimuths referred to true, grid, and magnetic north.	Field tests employing actual DEM/VAL location, altitude, and azimuth determining equipment that compare computed data to surveyed position data derived by other methods. AFAS simulator with C^3 Subsystem that receives location, altitude and tube azimuth from the simulator's own Entity State PDUs and uses the received data to update the BCC and other components of the C^3 Subsystem. Although this approach does not verify the functioning of AFAS's actual self location/gun pointing equipment, it does provide data to support verification of the functioning of other C3 Subsystems that use position and azimuth data.	AFAS's location, altitude, and tube azimuth on virtual terrain is identical to the data in the BCC and other components (i.e. decision aids) in the C^3 Subsystem.	AFAS's location AFAS's altitude AFAS's tube azimuth	Entity State PDU Entity State PDU Entity State PDU
Interior Ballistics. The C^3 subsystem shall perform the interior ballistics calculations required to achieve the projectile muzzle velocity required to engage the assigned target. The interior ballistics calculations shall include compensation for variations in parameters that affect muzzle velocity consistent with bias and precision requirements.	Live fire			

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Muzzle Velocity Compensation. The C^3 subsystem shall be capable of compensating for round-to-round variation in muzzle velocity. Muzzle velocity shall be recorded for every round fired.	Live fire			
Exterior Ballistics. The C3 Subsystem shall be capable of compensating for non-standard meteorology. Exterior ballistics computations shall also address, as the situation mandates, any other parameters which affect exterior ballistics such as visibility and height of clouds which affect M712 Copperhead missions.	Live fire			
Minimum Quadrant Elevation. As part of the exterior ballistic solution, the C^3 subsystem shall uniquely determine the minimum quadrant elevation associated with each mission and check for compliance with it and other masks to firing in accordance with the commander's/mission criteria. The C^3 Subsystem shall also check for clearance of all intermediate crests. The checks for intermediate crest clearance shall use digital map databases available as standard products from the Defense Mapping Agency.	Field tests involving actual DEMVAL equipment that measure immediate crests and locate obstructing intermediate crests along the projectile's trajectory and determine minimum quadrant elevation.			
Projectile Weight Compensation. The C^3 Subsystem shall perform both interior and exterior ballistic computations using individual weights of projectiles contained in the on-board magazine accurate to 0.05 kg (0.1 lb). For situations wherein the projectiles in the AFAS magazine have not been weighed and coded to the nearest 0.05 (0.1 lb), the C^3 Subsytem shall compute ballistics based on the current square method of weighing projectiles. When such projectiles are used, the associated degradation in precision associated with the less accurately known weight is acceptable.	Live fire			
Terminal Ballistics. The C3 Subsystem shall perform terminal ballistics computations to achieve the terminal effects desired. Terminal ballistics shall be performed integral to internal and external and exterior ballistics and shall address parameters such as height of burst, fuze, projectile type, and weather.	Live fire			

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Senior to Subordinate Howitzer - Tactical and Technical Fire Control. When the AFAS is operating as a senior or subordinate howitzer, the C^3 Subsystem shall be capable of providing tactical and technical fire control for itself and one subordinate howitzer at the direction of the POC when the two howitzers are separated by no more than 1 km. The C^3 Subsystem shall provide the same level of tactical and technical fire capabilities for itself and its subordinate as it normally provides for itself. The capabilities of the C^3 Subsystem shall be such that the senior howitzer suffers no degradation in its ability to simultaneously execute its own assigned mission. When operating in this mode, both howitzers shall execute the same missions; i.e. all missions shall be executed as two gun missions for the duration of the senior/subordinate link. Round to round corrections for the subordinate howitzer are not required. The subordinate howitzer will only shoot fire for effect missions or the fire for effect phase of adjust fire type missions.	AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if AFAS's C^3 Subsystem can respond to fire missions within the allotted time frame during senior - subordinate howitzer operations. Live fire to determine the impact of senior/subordinate responsibilities of senior howitzer responsiveness in the actual firing.	Distance between senior and subordinate howitzer Senior AFAS and subordinate AFAS mission response times	**Location**	
			Location of senior AFAS	Entity State PDU
			Location of subordinate AFAS	Entity State PDU
			Time	
			Time senior howitzer acknowledges fire mission	Event Report PDU
			Time first round fired by senior howitzer	Fire PDU
			Time first round fired by subordinate howitzer	Fire PDU
			For MRSI missions time span between impact of first and last round fired by senior howitzer	Detonation PDU
			For MRSI missions time span between impact of first and last round fired by subordinate howitzer	Detonation PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Senior to Subordinate Howitzer - Gun Laying. When AFAS is operating as a senior or subordinate howitzer, the C^3 Subsystem shall be capable of providing location and orientation data to a subordinate howitzer that has lost the capability to provide the data for itself. This function shall be provided when the two howitzers are separated by up to 1 km. Performance of this function shall not require crew members of either howitzer to leave their stations. This function shall be completed within two minutes of the time the two howitzers have stopped in their respective firing positions. Line of sight between the two howitzers is permissible. There shall be no more than a 10 percent degradation in the pointing accuracy of the subordinate howitzer.	Field testing using surveyed sites to determine accuracy of orientation data provided by the senior howitzer to the subordinate howitzer. AFAS simulator equipped with BCC, radios, modem, crew station displays, and AFAS software package to determine if orientation data provided to the subordinate howitzer is reasonably accurate, given the state of the art of virtual terrain. Simulation would also exercise and verify soldier-machine interfaces in senior to subordinate howitzer procedures.	Distance between senior and subordinate howitzer Accuracy of orientation data provided to the subordinate howitzer	**Location** Actual location of senior AFAS Actual location of subordinate AFAS Location provided to subordinate howitzer **Azimuth** Azimuth of fire of senior howitzer Azimuth of fire provided to subordinate howitzer **Altitude** Altitude provided to subordinate howitzer Actual altitude of subordinate howitzer	 Entity State PDU Entity State PDU Signal PDU Entity State PDU Signal PDU Signal PDU Entity State PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Radios and Nets. The C^3 Subsystem shall use Single Channel Ground and Airborne Radio Systems (SINCGARS) AN/VRC-92A (long range receiver / transmitters [R/T]) combat net radio for voice and data communications. One R/T will be dedicated to voice and the other to data communications. The C^3 Subsystem digital radio shall always operate on the platoon fire direction net and its voice radio on the battery command net. All digital command and control messages including the assignment of fire missions shall be received via this link.	AFAS simulator with communications capabilities replicating tactical radios and modems.	Decipherable digital messages are exchanged between AFAS, FARV and POC. Crew has serviceable voice communi-cations.	**Station identification** Sender Receiver **Time (Voice communications have time stamp only)** Time message transmitted Time message acknowledged by receiving node **Message type (message type pertains to digital messages only; voice messages tracked by time stamp)** **Message content** Digital Voice **Communications Medium** Radio net ID	 Transmitter PDU Receiver PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU
Automated Fire Support. The C^3 Subsystem shall be capable, when enabled by the COS, of automatically responding to calls for fire from authorized target acquisition sources. Identification of authorized sources shall be as directed by the POC. Direct links with target acquisition sources shall be accomplished through the POC which provides for the automatic relay of the message from the source's net to the platoon fire direction net.	AFAS simulator equipped with BCC, radios, modem, and crew station displays.	Time message received by AFAS from POC authorizing a direct link between AFAS and a target acquisition source Time COS establishes direct link with target acquisition source	**Station identification** Sender Receiver **Time** Time message transmitted Time message acknowledged by receiving node **Message type** **Message content** **Communications Medium** Radio net ID	 Transmitter PDU Receiver PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual Entries. The C^3 Subsytem shall be capable of accepting fire commands for manual entry by the crew that are received over the battery command (voice) net.	Live fire SIL AFAS simulator equipped with BCC and radios.	Comparison of voice fire commands with BCC data entries	**Content of voice fire command** (may requirc human recognition and recording of content)	Signal PDU
			Data manually entered into BCC	Event Report PDU
Flexibility of Use. The C^3 Subsystem shall provide the capability for the two radios to exchange voice and data roles without the need for the crew to physically change interconnections. If a single failure occurs, the remaining radio shall be dedicated to the digital net. If both radios fail, the howitzer shall either operate with another howitzer in a subordinate role if the tactical situation warrants or shall be considered out of action.	AFAS simulator with communications capabilities replicating tactical radios and modems with a simulation capability to link two AFASs together by wire in the event of failure of both radios in one AFAS.	AFAS crew has serviceable digital and voice communi-cations when two radios are operational. Decipherable digital messages are exchanged between AFAS, FARV and POC when a single radio is operational. AFAS crew connects AFAS with serviceable radios to an AFAS with no radios	**Station identification**	
			Sender	Transmitter PDU
			Receiver	Receiver PDU
			Time (Voice communications have time stamp only)	
			Time message transmitted	Signal PDU
			Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiver	Event Report PDU
			Time when one radio inoperable	Event Report PDU
			Time when two radios inoperable	Event Report PDU
			Time when communications initiated between Senior and Subordinate (disabled) howitzer by a wire connection..	Event Report PDU
			Message type (message type pertains to digital messages only; voice messages tracked by time stamp)	Signal PDU Signal PDU
			Message content	
			Digital	Signal PDU
			Voice	
			Communications Medium	
			Radio net ID	

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C³)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Internal Communications. Internal communications between crew members shall be provided via the Vehicular Intercom System.	AFAS simulator with tactical or commercial crew intercom. Although an AFAS simulator does not provide the fidelity to verify operations of communications equipment, the radios will enable the evaluation of various C3 configurations and soldier-machine interfaces.	Serviceable voice intercom is provided to the crew	**Time Stamped Voice Audio** **Communications Medium** Intercom	Signal PDU Signal PDU
Intercom Ports. Intercom ports shall be provided at each crew station and at each remote location a crew member may be required to occupy. A port shall be provided on the exterior of the system to allow communications with personnel outside the vehicle.	AFAS with tactical or commercial intercom ports	Intercom ports support digital and voice traffic.	**Time Stamped Voice Audio** **Communications Medium** Intercom	Signal PDU Signal PDU
Audio Alerts. System generated audio alerts shall be capable of being injected into the intercom.	AFAS simulator with installed C³ Subsystem	System Survivability by type and number of audio alerts activated.	**Number of operational AFASs at end of experiment by type of audio alerts activated** ID of each operational vehicle Types of audio alerts activated by time and operational vehicle ID **Number of AFASs sustaining combat damage and/or requiring unscheduled maintenance at end of experiment by alerts activated** ID of each disabled vehicle Nature of combat damage or maintenance deficiency Types of audio alerts activated by time and disabled vehicle ID	 Entity State PDU Event Report PDU Entity State PDU Entity State PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Inter-vehicular Communications. The C^3 Subsystem shall be capable of communicating with selected / designated howitzers and other resupply vehicles through the use of the combat net radio set.	AFAS simulator with communications capabilities replicating tactical radios and modems.	Crew has serviceable voice communi-cations.	**Station identification**	
			Sender	Transmitter Signal PDU
			Receiver	Receiver PDU
		Digital messages exchanged among AFASs and FARVs are decipherable among all nodes	**Time (Voice communications have time stamp only)**	
			Time message transmitted	Signal PDU
			Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiver	Event Report PDU
		Percent of node and net use	Message wait time by node, net, and priority	Event Report PDU
			Message type and priority (pertains to digital messages only; voice messages tracked by time stamp)	Signal PDU
		Number of messages transmitted by node, net, and priority	**Message content**	
			Digital	Signal PDU
			Voice	Signal PDU
		Average queued message wait time by node, net, and priority	**Communications Medium**	
			Wire	Signal PDU
			Radio net ID	Signal PDU
		Average number of queued messages by node, net, and priority		

Subject of Experimentation/Testing: AFAS Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Safety Aids. The C^3 Subsystem shall include capabilities to support the crew in monitoring system safety status.	AFAS simulator with installed C^3 Subsystem	Number of surviving operational AFASs by type and number of safety aids/alerts activated.	**Number of operational AFASs at end of experiment by type of safety aid/alert activated**	
			ID of each operational vehicle	Entity State PDU
			Types of safety alerts activated by time and operational vehicle ID	Event Report PDU
		Number of AFASs sustaining combat damage or inoperable due to maintenance by type and number of safety aids/alerts activated.	**Number of AFASs sustaining combat damage and/or requiring unscheduled maintenance at end of experiment by safety aids/alerts activated**	
			ID of each disabled vehicle	Entity State PDU
			Nature of combat damage or maintenance deficiency	Entity State PDU
			Types of safety alerts activated by time and disabled vehicle ID	Event Report PDU
Identification Friend or Foe (IFF). The C^3 Subsystem shall use standard Battlefield Combat Identification System procedures and equipment to reduce the potential for fratricide.	AFAS simulator with installed C^3 Subsystem and IFF	IFFs correctly identify entities detected by the crew or the C^3 Subsytem.	**Entity Type**	
			IFF entity type	Event Report PDU
			Actual entity type	Entity Type PDU
			Force Identification	
			IFF force identification	Event Report PDU
			Actual Force identification	Entity Type PDU

Subject of Experimentation/Testing. AFAS Command, Control, Communications (C^3)

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment.

2.1 Specifications supportable by DIS. Based on the results derived from the above matrix, DIS experimentation/testing appears feasible to assess the operational and technical tradeoffs in AFAS specifications addressing the following areas:

- C^3 Subsystem response time within overall AFAS response time
- C^3 Subsystem's capability to support AFAS rates of fire for a single projectile type and mixed projectile types
- C^3 Subsystem's capability to support MRSI mission time of impact requirements for a single projectile type and mixed projectile types
- Digital interfaces
- C^3 Subsystem's capability to support direct fire missions
- Degraded communications
- Message formats and content needed to support POC, AFAS, and FARV digital communications
- Placement of internal intercom ports
- Audio and safety alerts
- Centralized AFAS operations
- Decentralized AFAS operations
- Fire mission preplanning
- Fire mission coordination
- Fire support display
- Final protective fire updates
- Tactical fire control
- Senior to subordinate howitzer operations
- Linkage of AFAS to a target acquisition source through a POC relay
- IFF operations

2.2 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications above. Analysts and testers can run the same experiment altering designs to determine operational and technical tradeoffs offered by alternative C^3 configurations. Installation of an actual C^3 Subsystem prototype in an AFAS simulator provides the opportunity to experiment with various soldier-machine interfaces (SMIs), required messaging, net and node message loading, and system and software design architectures to determine the best fit to meet overall response times and required rates of fire. Placing the AFAS simulator on a combined arms virtual battlefield does not permit validations of firing accuracy to the degree specified in the AFAS specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Number of threat entities sustaining combat damage by AFAS indirect or direct fire by projectile type

Subject of Experimentation/Testing. AFAS Command, Control, Communications (C^3)

- Number of threat entities blinded by AFAS smoke missions by indirect or direct fire
- Percent of node and net use by various phases of the battle
- Number of messages transmitted by node, net, and priority
- Average queued message wait time by node, net and priority
- Average number of queued messages by node, net, and priority
- Number of threat entities illuminated by AFAS illumination missions
- Number of fire support coordination measure and battlefield geometry violations
- Number of fratricides resulting from violation of fire support coordination measures and battlefield geometry
- Number of AFASs surviving at the end of the battle/scenario
- Number of missions fired
- Number of projectiles fired by type
- Highest number of projectiles fired by type by minute for a duration of 3 minutes or longer
- Number of MRSI missions fired
- Number of MRSI projectiles fired by type, mission and range
- Mission response time by mission for AFAS while emplaced
- Mission response time by mission for AFAS while moving
- Mission response time by mission for senior AFAS while emplaced
- Mission response time by mission for senior AFAS while moving
- Time span for impact of all MRSI rounds by mission and range
- Time to process and fire M712 Copperhead by round and mission

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator complete with C^3 Subsystem with BCC, 2 radios, intercom modems, crew stations, crew displays, supporting software.
- One FARV simulator and crew or FARV SAFOR and SAFOR controller to support resupply operations. Fire Support Automated Test System (FSATS) could be upgraded to support digital messaging from a SAFOR FARV to an AFAS manned simulator during docking operations to coordinate and control ammunition and fuel transfer.
- One LRP SAFOR and LRP controller to support FARV upload/download operations.

Subject of Experimentation/Testing. AFAS Command, Control, Communications (C^3)

- One AFAS SAFOR and SAFOR controller to support senior to subordinate AFAS operations. FSATS could be upgraded to support digital messaging from a SAFOR Subordinate AFAS to a Senior AFAS manned simulator to support senior/subordinate howitzer operations.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield. FSATS could be employed as an alternative to generate calls for fire that drive a highly controlled scenario.
- One AFATDS POC computer operator to process the observer's call for fire. Another alternative is to upgrade FSATS POC node so that the FSATS POC may interface with AFAS and FARV. Testers could then embed the scenario in FSATS and allow the AFAS and FARV crews to interact with FSATS message traffic generated by the POC or observer nodes as appropriate.
- Threat SAFOR operations order and controller to execute order.
- Friendly force operations order with fire support coordination measures and battlefield geometry and controller to execute order.

Subject of Experimentation/Testing. FARV Command, Control, and Communications (C³). The C³ Subsystem provides for system level control of the FARV. It provides FARV with the capability to communicate and is comprised of the following elements: displays and controls for each crew member to include exterior vision devices; fire control computations and commands for the control of defensive armament pointing elements; tactical planning and execution support to the crew; internal and external communications equipment; and the capability to determine the system's present location in support of navigation.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Command, Control, and Communications (C³) Digital Data Interface. The system shall be compatible and interactive with the Advanced Field Artillery Tactical Data System (AFATDS) using protocols specified in MIL-STD-188-200/VM. The system shall be interoperable with AFAS to execute its intended mission.	FARV simulator equipped with radios, modem, and crew station displays that are compatible with AFATDS.	Digital messages exchanged among POC, AFASs, and FARVs are decipherable among all nodes	**Station identification**	
			Sender	Transmitter Signal PDU
			Receiver	Receiver PDU
			Time	
			Time message transmitted	Signal PDU
		Percent of node and net use	Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiver	Event Report PDU
		Number of messages transmitted by node, net, and priority	Message wait time by node, net, and priority	Event Report PDU
			Message type and priority	Signal PDU
			Message content	Signal PDU
		Average queued message wait time by node, net, and priority	**Communications Medium**	
			Wire	Signal PDU
			Radio net ID	Signal PDU
		Average number of queued messages by node, net, and priority		

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communication Link. A voice and data communications connection shall be automatically established between the docking systems during docking. This link shall provide for the transfer of all control data required to coordinate the transfer processes. The crew shall have direct control of all transfer processes without having to leave their crew stations (except for manual rearm). For rearm, this link shall be established automatically as a part of the docking process	FARV simulator equipped with radios, modem, intercom, and crew station displays	Digital messages are exchanged between FARV and AFAS by wire connection and are decipherable between nodes.	**Station identification**	
			Sender	Transmitter PDU
			Receiver	Receiver PDU
			Time (Voice communications have time stamp only)	
			Time message transmitted	Signal PDU
		Crew has serviceable voice communi-cation by wire connection with the FARV.	Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiver	Event Report PDU
			Message type (message type pertains to digital messages only; voice messages tracked by time stamp)	Signal PDU
			Message content	
		Number of digital messages transmitted by type, receiver processing time, and message wait time.	Digital	Signal PDU
			Voice	Signal PDU
			Communications Medium	
			Wire	Signal PDU
			Items resupplied	
		Number of projectiles and amount of propellant, and fuel transferred and time consumed to complete the transfer by item.	Number of projectiles transferred by type	Event Report PDU
			Amount of propellant transferred	Event Report PDU
			Amount of Fuel Transferred	Event Report PDU
			Time required to complete resupply	
			Time to transfer all projectiles	Event Report PDU
			Time to transfer propellant	Event Report PDU
			Time to transfer fuel	Event Report PDU

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Radios. The C^3 Subsystem shall use Single Channel Ground and Airborne Radio Systems (SINCGARS) AN/VRC-92A (long range receiver / transmitters [R/T]) combat net radio for voice and data communications. One R/T will be dedicated to voice and the other to data communications.	FARV simulator with communications capabilities replicating tactical radios and modems.	Decipherable digital messages are exchanged between AFAS, FARV and POC. Crew has serviceable voice communi-cations.	**Station Identification**	
			Sender	Transmitter PDU
			Receiver	Receiver PDU
			Time (Voice communications have time stamp only)	
			Time message transmitted	Signal PDU
			Time message acknowledged by receiving node	Signal PDU
			Message type (message type pertains to digital messages only; voice messages tracked by time stamp)	Signal PDU
			Message content	
			Digital	Signal PDU
			Voice	Signal PDU
			Communications Medium	
			Radio net ID	Signal PDU

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Automatic Response to Support Requests. The C^3 Subsystem shall be capable of automatically processing requests for support and then automatically relaying information back to the requester. The system shall allow the crew to disable this function and to hold the subsystem's prepared response transmission for crew release.	FARV simulator equipped with radios, modem, intercom, crew station displays, and decision support system software	Number of resupply requests in which FARV automatically provides information to the requester.	**Station Identification**	
			Sender	Transmitter PDU
			Receiver	Receiver PDU
			Time	
			Time message received by FARV C^3 Subsystem	Signal PDU
		Number of resupply requests in which FARV semi-automatically provides information to the requester.	Time message transmitted to requester	Signal PDU
			Message type and response	
			Type=resupply	Signal PDU
			Automatic response	Event Report PDU
			Semi-automatic response	Event Report PDU
			Message content	Signal PDU
			Communications Medium	
			Wire	Signal PDU
			Radio net ID	Signal PDU
Manual Data Entry. The C^3 Subsystem shall allow the crew to enter resupply coordination information, for relay back to requester, manually in response to external taskings.	FARV simulator equipped with radios, modem, intercom, and crew station displays	Comparison of voice data to manually entered data	**Time and content of voice resupply request** (may require human recognition and recording of content)	Signal PDU
			Data manually entered into BCC	Event Report PDU

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Flexibility of Use. The C^3 Subsystem shall provide the capability for the two radios to exchange voice and data roles without the need for the crew to physically change interconnections. If a single failure occurs, the remaining radio shall be dedicated to the digital net.	FARV simulator with communications capabilities replicating tactical radios and modems.	FARV crew has serviceable digital and voice communications when two radios are operational. Decipherable digital messages are exchanged between AFAS, FARV and POC when a single radio is operational.	**Station Identification**	
			Sender	Transmitter PDU
			Receiver	Receiver PDU
			Time (Voice communications have time stamp only)	
			Time message transmitted	Signal PDU
			Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiving node	Event Report PDU
			Time when one radio inoperable	Event Report PDU
			Time when two radios inoperable	Event Report PDU
			Message type (message type pertains to digital messages only; voice messages tracked by time stamp)	
			Message content	Signal PDU
			Digital	Signal PDU
			Voice	
			Communications Medium	Signal PDU
			Radio net ID	
Internal Communications. Internal communications between crew members shall be provided via the Vehicular Intercom System.	FARV simulator equipped with radios, modem, intercom, and crew station displays Although a FARV simulator does not provide the fidelity to verify operations of communications equipment, the radios will enable the evaluation of various C3 configurations and soldier-machine interfaces.	Serviceable voice intercom is provided to the crew	**Time Stamped Voice Audio**	Signal PDU
			Communications Medium	
			Intercom	Signal PDU

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Intercom Ports. Intercom ports shall be provided at each crew station and at each remote location a crew member may be required to occupy. A port shall be provided on the exterior of the system to allow communications with personnel outside the vehicle.	FARV with tactical or commercial intercom ports	Serviceable voice intercom is provided to the crew	**Time Stamped Voice Audio**	Signal PDU
			Communications Medium	
			Intercom	Signal PDU
Audio Alerts. System generated audio alerts shall be capable of being injected into the intercom.	FARV simulator with installed C^3 Subsystem	System Survivability by type and number of audio alerts activated.	**Number of operational FARVs at end of experiment by type of audio alerts activated**	
			ID of each operational vehicle	Entity State PDU
			Types of audio alerts activated by time and operational vehicle ID	Event Report PDU
			Number of FARVs sustaining combat damage and/or requiring unscheduled maintenance at end of experiment by alerts activated	
			ID of each disabled vehicle	Entity State PDU
			Nature of combat damage or maintenance *deficiency*	Entity State PDU
			Types of audio alerts activated by time and disabled vehicle ID	Event Report PDU

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Inter-vehicular Communications. *The* Subsystem shall be capable of communicating with selected / designated howitzers and other resupply vehicles through the use of the combat net radio set.	FARV *simulator* with communications capabilities replicating tactical radios and modems.	Crew has serviceable voice communi-cations.	**Station identification**	
			Sender	Transmitter Signal PDU
			Receiver	Receiver PDU
		Digital messages exchanged among AFASs and FARVs are decipherable among all nodes	**Time (Voice communications have time stamp only)**	
			Time message transmitted	Signal PDU
			Time message acknowledged by receiving node	Signal PDU
			Time message processed by receiver	Event Report PDU
			Message wait time by node, net, and priority	Event Report PDU
		Percent of node and net use	**Message type and priority (pertains to digital messages only; voice messages tracked by time stamp)**	Signal PDU
		Number of messages transmitted by node, net, and priority	**Message content**	
			Digital	Signal PDU
			Voice	Signal PDU
		Average queued message wait time by node, net, and priority	**Communications Medium**	
			Wire	Signal PDU
			Radio net ID	Signal PDU
		Average number of queued messages by node, net, and priority		

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Safety Aids. The C^3 Subsystem shall include capabilities to support the crew in monitoring system safety status.	FARV simulator with installed C^3 Subsystem	Number of surviving operational FARVs by type and number of safety aids/alerts activated.	**Number of operational FARVs at end of experiment by type of safety aid/alert activated**	
			ID of each operational vehicle	Entity State PDU
			Types of safety alerts activated by time and operational vehicle ID	Event Report PDU
		Number of FARVs sustaining combat damage or inoperable due to maintenance by type and number of safety aids/alerts activated.	**Number of FARVs sustaining combat damage and/or requiring unscheduled maintenance at end of experiment by safety aids/alerts activated**	
			ID of each disabled vehicle	Entity State PDU
			Nature of combat damage or maintenance deficiency	Entity State PDU
			Types of safety alerts activated by time and disabled vehicle ID	Event Report PDU
Identification Friend or Foe (IFF). The C^3 Subsystem shall use standard Battlefield Combat Identification System procedures and equipment to reduce the potential for fratricide.	FARV simulator with installed C^3 Subsystem and IFF	IFFs correctly identify entities detected by the crew or the C^3 Subsytem.	**Entity Type**	
			IFF entity type	Event Report PDU
			Actual entity type	Entity Type PDU
			Force Identification	
			IFF force identification	Event Report PDU
			Actual Force identification	Entity Type PDU

Subject of Experimentation/Testing: FARV Command, Control, and Communications (C^3)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Centralized Control. Depending on the level of centralized control, the FARV will either respond to mission plans and execution instructions from the POC, directly from an AFAS, or be link-relayed through the POC to an AFAS. By including the POC in the control link, FARV systems can support the AFAS systems on either a one on one basis or can be pooled to add greater flexibility and throughput. In general, the AFAS will report its operational status and support requirements to the POC which will then dispatch a resupply vehicle (FARV) to rearm/refuel the AFAS as required. This will generally take place as the howitzer moves into a new position. Once the FARV has located the supported AFAS, it will be the active participant of the docking procedure with the exception of any maneuvering the AFAS may be required to perform to place itself in an acceptable supply position.	FARV simulator with installed C^3 Subsystem	Number of missions and projectiles fired	**Number of fire missions fired**	
			Mission Fired Reports (MFR) transmitted by AFAS to POC	Event Report PDUs to designate each MFR transmitted
			Projectile type and number fired	Fire and Detonation PDUs
		Number of threat and friendly losses	**Vehicles sustaining combat damage**	
			Number of AFASs	Entity State PDU
			Number of FARVs	Entity State PDU
			Number and type of threat entities	Entity State PDU
		Number of AFAS resupply requests sent directly to the FARV and time to complete resupply.	**Number of AFAS resupply requests sent directly to FARV**	
			Message type = resupply	Signal PDU
			Message sender	Transmitter PDU
			Message receiver	Receiver PDU
			Time received and acknowledged	Signal PDU
			Time resupply completed	Event Report PDU
		Number of AFAS resupply requests sent to the POC and time to complete resupply.	**Number of AFAS resupply requests sent to POC**	
			Message type = resupply	Signal PDU
			Message sender	Transmitter PDU
			Message receiver	Receiver PDU
			Time received and acknowledged	Signal PDU
			Time resupply completed	Event Report PDU

Subject of Experimentation/Testing. Subject of Experimentation/Testing. FARV Command, Control, and Communications (C^3)

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment.

2.1 Specifications supportable by DIS. Based on the results derived from the above matrix, DIS experimentation/testing appears feasible to assess the operational and technical tradeoffs in FARV specifications addressing the following areas:

- C^3 digital data and voice interfaces
- C^3 configuration
- Automatic and semiautomatic responses to resupply requests
- Degraded communications
- Placement of internal intercom ports
- Audio and safety alerts
- Message formats and content needed to support POC, AFAS, and FARV digital communications
- IFF operations
- FARV centralized and decentralized operations

2.2 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications in paragraph 2.1. Analysts and testers can run the same experiment repeatedly *altering designs* to determine operational and technical tradeoffs offered by alternative C^3 configurations. Installation of an actual C^3 Subsystem prototype in a FARV simulator provides the opportunity to experiment *with various soldier-machine interfaces, required messaging,* net and node message loading, and software design architecture's to determine the best fit to meet overall response times for resupply, transloading, and downloading of fuel and ammunition. Placing the FARV simulator on a combined arms virtual battlefield permits evaluation of design changes that can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Percent of node and net use by various phases of the battle
- Number of messages transmitted by node, net, and priority
- Average queued message wait time by node, net and priority
- Average number of queued messages by node, net, and priority
- Time required to complete resupply, transload, and download under centralized, decentralized operations, and various C3 configurations and messaging.
- Number of missions fired
- Number of threat entities sustaining combat damage
- Number of threat entities blinded by AFAS smoke missions
- Number of threat entities illuminated by AFAS illumination missions
- Number of IFF warnings, audio alerts, and safety warnings
- Number of surviving, operational AFASs and FARVs
- Number of AFASs and FARVs sustaining combat damage or maintenance deficiency.

Subject of Experimentation/Testing. Subject of Experimentation/Testing. FARV Command, Control, and Communications (C^3)

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One FARV crew to man a FARV simulator
- One FARV simulator equipped with C3 Subsystem complete with radios, modems, crew stations, crew displays, supporting software.
- One AFAS simulator and crew or AFAS SAFOR and SAFOR controller to fire [illegible] ions and support resupply operations. Fire Support Automated Test System (FSATS) could be upgraded to support digital messaging from a SAFOR A[illegible] FARV manned simulator during docking operations to coordinate and control ammunition and fuel transfer.
- One LRP SAFOR and LRP controller to support FARV upload/download [illegible] ons.
- One FARV SAFOR and SAFOR controller to support transload operations between FARVs. FSAT could be upgraded to support digital messaging from a SAFOR FARV to a FARV manned simulator during transloading operations to coordinate and control ammunition and fuel transfer.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield. FSATS could be employed as an alternative to generate calls for fire that drive a highly controlled scenario.
- One AFATDS POC computer operator to process the observer's cali for fire. Another alternative is to upgrade FSATS POC node so that the FSATS POC may interface with AFAS and FARV. Testers could then embed the scenario in FSATS and allow the AFAS and FARV crews to interact with FSATS message traffic generated by the POC or observer nodes as appropriate.
- Threat SAFOR operations order and controller to execute the order
- Friendly force operations order with fire support coordination measures and battlefield geometry and controller to execute the order

Subject of Experimentation/Testing. AFAS Primary Armament

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Range. Required maximum range (consistent with the bias and precision requirements)- not less than 30 km unassisted projectile not less than 40 km assisted projectile Required minimum range (consistent with the bias and precision requirements)-not greater than 6 km at 200 mils elevation. The system shall be zoned to provide range overlap. This shall be accomplished for all required projectile fuze combinations except M712 Copperhead. Charges shall overlap by 10% of the maximum range of the lower zone or 1500 meters, whichever is shorter, when firing between 200 mils quadrant elevation and maximum range elevation. Charges shall also overlap by 10% of the maximum range of the lower zone when firing between 1244 mils and maximum range elevation.	Live fire			
Rate of Fire. Required maximum rate of fire-10 rounds per minute for 3 minutes Required sustained rate of fire-3 rounds per minute against specified targets until on-board ammunition is exhausted. The system will also be capable of supporting variable rates of fire from 1 to 10 rounds per minute No more than 90 seconds following the completion of resupply (of any quantity of rounds up to maximum storage capacity), the system shall once again be capable of operating at the maximum rate of fire.	Live fire AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if AFAS subsystems can perform within their allotted time frames to achieve the required rates of fire.	Rate of fire	Time Time Ballistic Computation Computer (BCC) acknowledges fire mission Time resupply completed Time first round fired Time each subsequent round fired	Event Report or Message PDU NOTE: Start of the time interval may be at some point other than the time BCC acknowledges fire mission, such as the time which the BCC initiates execution of a preplanned fire mission. *Resupply Received PDU* Fire PDU NOTE: New enumeration values for several projectiles may be necessary (i.e. M110, M116, M712)

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Multiple round simultaneous impact (MRSI). MRSI missions-the system shall be capable of firing MRSI missions of at least 4 rounds at all ranges between 8 and 36 km with all rounds impacting within 4 seconds (first to last round). The system shall also be capable of firing MRSI missions consisting of two rounds up to the maximum achievable number of MRSI rounds.	Live fire	Total time between 1st and last round	**Time**	
	AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if AFAS can meet MRSI requirements and achieve the desired effects on the target, within the allotted time frames for each subsystem.		Time first round impacts	Detonation PDU
			Time last round last round impacts	Detonation PDU
		MRSI range	**Location**	
			Location of target in call for fire	Detonation PDU
NOTE: Implied in this specification is the requirement to determine the effects of MRSI missions so that if the DEMVAL contractor's design falls short of or exceeds the MRSI range or time requirements, the impact of the design shortfall or enhancement can be evaluated.			Location of firing AFAS	Fire PDU
		Outcome of MRSI engagement	**Effects on target**	
			Vehicle and force identification	Detonation PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU
			Area illuminated	Suggest extension of DIS standards to allow representing illumination as an environmental entity, much like a smoke cloud is handled now.

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Mixed Projectile Types. For any given mission the system shall be capable of combining fuzed projectile types and sheaf's in any combination required to achieve the desired effect on target. NOTE: Implied in this specification is the requirement to meet AFAS rate of fire and mission response times when firing mixed projectile types.	Live Fire AFAS simulator equipped with BCC, radios, modems, and crew station displays to determine if BCC and soldier-in-the-loop can deliver mixed projectile types and achieve the desired effects on the target, within allotted time frames for each subsystem.	AFAS response time	**Time**	
			Time vehicle stops in firing position	Entity State PDU
			Time fire mission acknowledged by BCC	Event Report or Message PDU
			Time first round fired	Fire PDU
			Time last round fired	Fire PDU
		Projectile mix	**Projectile**	
			Type	Fire & Detonation PDUS
			Number fired	Fire & Detonation PDUS
		Outcome of indirect fire engagement	**Effects on Target**	
			Vehicle and force identification	Detonation PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU
			Area illuminated	Suggest extension of DIS standards to allow representing illumination as an environmental entity, much like a smoke cloud is handled now.

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Bias and Precision. When firing the M549A1 projectile, the system shall be capable of providing accurate fires through the following ranges at the prescribed circular error probable (CEP) listed in the table below. Accuracy requirements shall be met when firing the shortest time of flight trajectories. (Note: Bias is radius of a circle containing the MPIs of multiple occasions. One occasion is a number of rounds fired from the same gun with the same data for a short period of time. Precision is the radius from the MPI that produces a circle containing all rounds fired from a single gun with the same data on a single occasion.) Range Bias Precision Min. to 15 km 55m 40m 16 to 25 km 80m 75m 26 to 35 km 140m 120m 36 km to max. 215m 200m	Live fire			

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Responsiveness. When emplaced in a firing position, the system shall be capable of responding to a fire mission with 20 seconds. The interval shall start when the system acknowledges the error free receipt of the fire mission request and shall end when the first round is fired. This time interval shall include all on-board fire control computations, regardless of the mission. When moving, the system shall be capable of responding to a fire mission with 45 seconds. The interval shall start when the system has stopped in a suitable firing position and acknowledged the error free receipt of the fire mission request. The interval shall end when the first round is fired. The interval shall include the time required to emplace the howitzer (emplacement being defined as all operations required to prepare for the mission beyond simply stopping) as well as on board fire control computations, regardless of the mission. NOTE: The specifications above imply that the time interval includes time required for autoloading and crew interaction to fire the mission as well as on-board fire control computations. Response time from cold start (non-operational status) to fully mission capable status-15 minutes Response time from warm status to fully mission capable status-45 seconds	Live fire SIL AFAS simulator equipped with BCC, radios, modem, and crew station displays to determine if BCC and other subsystems can respond within their allotted time frames to meet the overall response time.	Mission response time for emplaced AFAS Mission response time for moving AFAS Mission response time for AFAS in cold status Mission response time for AFAS in warm status	**Time** Time fire mission acknowledged by BCC Time BCC completes tactical fire direction Time BCC completes technical fire direction Time autoloader completes loading of first round Time first round fired Time vehicle stops in firing position Time primary power applied to system (no auxiliary power running) Time all subsystems fully operational Time primary power applied to system (auxiliary power is running) Time all subsystems fully operational	Entity State PDU Event Report or Message PDUs Event Report or Message PDUs Event Report or Message PDUs Event Report or Message PDUs Fire PDU Event Report or Message PDUs Event Report or Message PDUs Event Report or Message PDUs Event Report or Message PDUs
Ammunition Storage. The system shall provide for storage of no less than 60 fuzed projectiles, two M712 Copperhead projectiles, and a usable quantity of liquid propellant corresponding to 75 percent of the top zone charge for a total quantity of 60 M549A1 projectiles and two M712 projectiles.	Live fire			

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Automated Ammunition Access. Fuzed projectiles and liquid propellant stored within the AFAS shall be automatically accessible by the system. The two M712 projectiles may be manually accessed. NOTE: Implied in the above specification is that accessibility must allow the crew to set the pulse repetition frequency (PRF) code and time settings on the M712 projectile as well as load it. If the BCC automatically sends the designate command to the observer to provide the observer sufficient time to designate the target during the last 13 seconds of the projectile's time of flight this design feature can also be tested.	Live fire for projectiles automatically accessed. AFAS Simulator with breech and M712 projectiles for manual access and loading. Sensor(s) in breech to determine PRF code and time settings on M712 projectile.	Accessibility of M712 projectiles permit the crew to accurately set PRF code and time and manually load the projectile Timeliness of designate command	**M712 Settings** Time setting provided by BCC M712 time set by crew Observer's assigned PRF code PRF code set by crew. **Loading** BCC indication that breech loaded and safe to fire **Time** Time BCC acknowledged fire mission Time BCC indicated that breech loaded and safe to fire Time of flight Time AFAS sent designate command to FDC and/or observer.	NOTE: M712 is not a supported munition type under DIS 2.03. An enumeration value for that entity needs to be added. Event Report Event Report Signal PDU or Event Report Event Report Event Report Event Report Event Report Fire and Detonation PDUs Signal PDU
Manual Ammunition Access. When required for maintenance or other operational reasons, fuzed projectiles and liquid propellant shall be capable of being manually downloaded at a rate of at least 130 complete rounds in less than 90 minutes with the system in an unpowered state.	Live fire Crew ammunition download drill using AFAS DEMVAL prototype			
Previously Rammed Round. Prior to ramming, the Primary Armament Subsystem shall check for a previously rammed round. If a round is found, the Primary Armament Subsystem shall notify the crew pending any further action. Primary Armament Subsystem shall be capable of firing a round rammed during a previous shot sequence.	Live fire			
Bore Clear Check. Prior to ramming, the Primary Armament Subsystem shall check to ensure that the cannon bore is clear of obstructions that could pose a safety hazard. The Primary Armament Subsystem shall check for a chambered projectile and debris which could cause a sticker.	Live fire			

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Fuze Setting. Electronic fuze setting shall be accomplished. Projectiles equipped with non-electronically set fuzes, such as M739A1(point detonating/delay), shall be preset prior to uploading into the howitzer. Copperhead fuze shall be manually set prior to ramming. Prior to ramming the Primary Armament Subsystem shall automatically set electronic fuzes for the projectiles that possess them. Timing of this event in the ammunition handling cycle shall not inhibit the ability of the system to perform round-to-round corrections via the fuze setting.	Live fire. For Copperhead. See Automated Ammunition Access above			
Confirmation of Fuzed Projectile. Prior to ramming any projectile, the system shall automatically verify the projectile/fuze coding matches the projectile/fuze designated by the fire control solution.	Live fire			
Projectile Ramming. The Primary Armament Subsystem shall be capable of automatically ramming fuzed projectiles into the forcing cone of the cannon without affecting the functional integrity of the projectile and fuze. The ram shall be sufficient to obviate fall back. The M712 Copperhead may be manually rammed.	Live fire			
Propellant Loading. All propellant handling functions necessary to fire the cannon shall be automated.	Live fire			
Verification of Projectile Firing. For each round fired, the Primary Armament Subsystem shall verify that the projectile has left the gun tube prior to ending the mission after the last round in a given mission is fired.	Live fire			
Gun Swabbing. If required, the Primary Armament Subsystem shall automatically swab the gun after firing.	Live fire			
Gun Positioning. The primary armament subsystem shall be capable of elevating the gun between -3 and 75 degrees elevation with respect to the platform.	Verify with DEMVAL prototype			
Misfire Procedures. The primary armament subsystem shall have crew misfire procedures, and crew and DD personnel procedures for extraction of stuck rounds.	Verify in AFAS operator manual and appropriate support maintenance manuals. Inspect projectile extraction tools.			

Subject of Experimentation/Testing. AFAS Primary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Direct Fire. The primary armament subsystem shall be capable of supporting the direct fire mission. NOTE: In addition to testing/experimenting with direct fire sighting and fire control equipment, sensors in the self defense suite may be tied into the experiment.	Live fire Simulator that provides sensor warnings and a direct fire sighting and firing capability to the gunner identical to that planned for AFAS.	Sensor activation	**Type of self defense sensor activated**	Event Report PDU
		Detection to firing time	**Time**	
			Time sensor activated alerting AFAS crew	Event Report PDU
			Time AFAS fires direct fire mission	Fire PDU
		Engagement range and point of impact	**Location**	
			Firing vehicle	Detonation PDU
			Target vehicle	Detonation PDU
			Location of ordnance impact if target vehicle engaged but not hit.	Detonation PDU
		Type projectile fired	**Projectile type and number fired**	Fire and Detonation PDUs
		Outcome of direct fire engagement	**Effects on AFAS and target vehicle**	
			Vehicle and force identification	Detonation PDU
			Operational vehicles	Entity State PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU

Subject of Experimentation/Testing. AFAS Primary Armament

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment.

2.1 Specifications supportable by DIS. Based on the results derived from the above matrix, DIS experimentation/testing appears feasible to assess the operational and technical tradeoffs in AFAS specifications addressing the following areas:

- Response time with single and mixed projectile types
- Rates of fire with single and mixed projectile types
- MRSI time of impact with single and mixed projectile types
- Effectiveness of indirect fire engagements involving serial and MRSI fire missions
- Manual access of M712 Copperhead projectile
- Direct fire

2.2 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering designs to determine operational and technical tradeoffs offered by alternative crew station configurations, soldier-machine interfaces (SMIs), BCC designs, and autoloading designs/times. For example if AFAS simulator software has a selectable autoloading time, the impact of various autoloading designs on overall response time and rate of fire requirements may be determined. Installation of an actual BCC prototype in the AFAS simulator provides the opportunity to experiment with various SMIs and BCC system and software design architecture's to determine the best fit to meet overall response time and rate of fire requirements. Placing the AFAS simulator on a combined arms virtual battlefield does not permit validations of firing accuracy to the degree specified in the AFAS specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Number of threat entities destroyed by AFAS indirect or direct fire by projectile type
- Number of threat entities damaged by AFAS indirect fire or direct fire by projectile type
- Number of threat entities blinded by AFAS smoke missions by indirect or direct fire
- Number of threat entities illuminated by AFAS illumination missions
- Number of missions fired
- Number of projectiles fired by type
- Highest number of projectiles fired by type by minute for a duration of 3 minutes or longer
- Number of MRSI missions fired
- Number of MRSI projectiles fired by type, mission and range
- Mission response time by mission for AFAS while emplaced
- Mission response time by mission for AFAS while moving
- Mission response time by mission for senior AFAS while emplaced
- Mission response time by mission for senior AFAS while moving
- Time span for impact of all MRSI rounds by mission and range

Subject of Experimentation/Testing. **AFAS Primary Armament**

- Time to process and fire M712 Copperhead by round and mission

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One FARV simulator and crew or FARV SAFOR and SAFOR controller to support resupply operations. Fire Support Automated Test System (FSATS) could be upgraded to support digital messaging from a SAFOR FARV to an AFAS manned simulator during docking operations to coordinate and control ammunition and fuel transfer.
- One LRP SAFOR and LRP controller to support FARV upload/download operations.
- One AFAS SAFOR and SAFOR controller to support senior to subordinate AFAS operations. FSATS could be upgraded to support digital messaging from a SAFOR Subordinate AFAS to a Senior AFAS manned simulator to support senior/subordinate howitzer operations.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield. FSATS could be employed as an alternative to generate calls for fire that drive a highly controlled scenario.
- One AFATDS POC computer operator to process the observer's call for fire. Another alternative is to upgrade FSATS POC node so that the FSATS POC may interface with AFAS and FARV. Testers could then embed the scenario in FSATS and allow the AFAS and FARV crews to interact with FSATS message traffic generated by the POC or observer nodes as appropriate.
- Threat SAFOR operations order and controller to execute order.
- Friendly force operations order with fire support coordination measures and battlefield geometry and controller to execute order.

Subject of Experimentation/Testing: AFAS Secondary Armament

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Decision Aids. The AFAS must have an embedded decision aid capability to assist the crewmen making decisions associated with *planning, monitoring* and executing system survivability.	Live or Virtual		**Capability**	
		Percent of planning done with Decision Aids	Number of survivability plans determined with Decision Aids	Event Report PDU
			Number of survivability plans determined without Decision Aids	Event Report PDU
			Crew comments on survivability plans determined with and without Decision Aids	X
		Percent of monitoring done with Decision Aids	Number of monitoring actions conducted with Decision Aids	Event Report PDU
			Number of monitoring actions conducted without Decision Aids	Event Report PDU
			Crew comments on monitoring actions conducted with and without Decision Aids	X
		Percent of execution done with Decision Aids	Number of survivability actions executed with Decision Aids	Event Report PDU
			Number of survivability actions executed without Decision Aids	Event Report PDU
			Crew comments on survivability actions executed with and without Decision Aids	X
Survivability Subsystem. The Survivability Subsystem comprises all passive and active measures related to protecting the AFAS crew and hardware systems. It interfaces heavily with all other subsystems.	Live or Virtual		**Time**	
		Average time passive measures activated	Time passive measure implemented	Event Report or Electromagnetic Emissions PDU
			Time passive measure completed	Event Report or Electromagnetic Emissions PDU
			Passive measure implemented	Event Report or Electromagnetic Emissions PDU
		Average time active measures activated	Time active measure implemented	Event Report or Electromagnetic Emissions PDU
			Time active measure completed	Event Report or Electromagnetic Emissions PDU
			Active measure implemented	Event Report or Electromagnetic Emissions PDU

Subject of Experimentation/Testing: AFAS Secondary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Firepower (Defensive). The system defensive armament shall provide for area suppression and defensive capability employable against threat ground forces, helicopters, reconnaissance vehicles and other lightly armored targets that fall within close-combat range.	Live or Virtual		**Capability**	
		Percent of effective engagements with secondary armament	Number of target engagements Number of targets defeated Type of force/vehicle engaged Range at which target was engaged Engagement with primary or secondary armament	Event Report PDU Entity State PDU Event Report PDU Entity State PDU Event Report PDU
			Effectiveness	
		Effectiveness of secondary armament	Number of rounds/missiles fired Number of target hits Range at which target hits occurred Type of force/vehicle engaged	Fire PDU Detonation PDU Fire and Detonation PDU Entity State PDU
Defensive Armament. The defensive armament for the system shall be a combat instrument capable of engaging targets at close combat range.	Live or Virtual		**Capability**	
			Minimum effective and safe range Maximum effective range Maximum sustained rate of fire Maximum rate of fire *Number of on-board rounds/missiles*	 Event Report PDU
			Range	
		Average engagement range	Distance at which target first engaged Distance at which target defeated or disengaged	Entity State PDU Entity State PDU
			Time	
			Time engagement stopped Time engagement started	Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Secondary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Safety.	Live or Virtual		**Capability**	
Firing the defensive weapon shall not introduce toxic products into the crew compartment in concentrations that exceed OSHA established limits.		Percent of warnings related to firing secondary armament	Record of firing the secondary armament Record of warnings attributed to firing the secondary armament Vehicle ID number	Fire PDU Event Report PDU Entity State PDU
The C3 Subsystem shall include capabilities to support the crew in monitoring system safety status.			Record of operator monitoring of safety status actions Record of operator safety status actions taken Reason for taking action	Event Report PDU Event Report PDU Event Report PDU
The system shall provide both audible and visible warnings to alert the crew to internal and external hazardous situations, e.g., fire, NBC contamination, LP spills, and vehicle backing up. These warnings shall not interrupt mission critical functions or create unsafe situations in tactical environments.			Number of warnings to alert crew Type of alert (audible, visual or both) Reason for warning Number of warnings that interrupted mission critical functions	Event Report PDU Event Report PDU Event Report PDU Event Report PDU
Power.	Live and Virtual		**Capability**	
The AFAS must be able to produce a reduced level of power which is capable of powering on-board computer, communications, position/navigation and survivability systems (less main armament and NBC overpressure) and starting the engine for at least 6 hours.			Record of reduced power operations of the survivability subsystem Record of reduced power operations for the survivability sensors systems	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
			Time	
		Median Time Reduced Power Level Operations were Conducted	Time reduced power level operations stopped Time reduced power level operations initiated Record of reduced power level operations Reason for reduced power level operations	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)

Subject of Experimentation/Testing: AFAS Secondary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Identification Friend or Foe (IFF). The C3 Subsystem shall use standard Battlefield Combat Identification System procedures and equipment to reduce the potential for fratricide.	Live or Virtual		**Capability**	
			Record of BCIS use	Event Report PDU
			Problems encountered with IFF identification	Event Report PDU
			Accuracy	
		Percent correct IFF replies	Number of IFF queries	Signal PDU
			Number of IFF successful replies	Signal PDU

Subject of Experimentation/Testing: AFAS Secondary Armament

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow demonstration and evaluation of various secondary armament weapon capabilities. The system could be looked at for integration of automation, ammunition storage capacity, self-defense decision aid execution and operator controls/displays. Assessment of the adequacy, maturity and compatibility of the secondary armament system to defeat threat targets could be made. The evaluation and selection of alternative technologies could also be made in the areas of effectiveness, efficiency, survivability ratios and hit probabilities. The technical characteristics of each weapon system could be assessed in terms of rates of fire, effective ranges and probability of hit and kill in an operational environment.

2.1 Stated specifications:

- Decision Aids
- Survivability Subsystem
- Firepower (Defensive)
- Defensive Armament
- Safety
- Identification Friend or Foe (IFF)

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the AFAS System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains threat air and ground forces, AFAS engagement of these systems could occur. Crew reactions, crew tasks, timeline analysis, weapon engagements and results could be gathered and the results assessed by different type of secondary armament system employed to determine the best solution to the secondary armament weapon. This sequence of events could evaluate the overall impact on system and crew's capability *to meet battlefield, system and secondary armament system* requirements. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the AFAS specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Ranges for engagement of threat targets
- Effectiveness of engagements
- Survivability of the AFAS following ground engagement
- Survivability of the AFAS following air engagement
- Effectiveness of active and passive measures
- Reduction of fratricide instances
- Effectiveness of Decision Aids to increase system survivability
- Effectiveness of multiple engagements when operating under single. paired and pooled operations

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update FARV information base on LRP locations, resupply requests and operations and battlefield information.
- Three AFAS and three FARV SAFOR to support paired and pooled self-defense operations
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order
- Threat ground and air vehicles and systems to conduct target engagements
- A Time Ordered Events List (TOEL)

Subject of Experimentation/Testing: FARV Secondary Armament

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Decision Aids. The FARV must have an embedded decision aid capability to assist the crewmen making decisions associated with Planning, monitoring and executing system survivability.	Live or Virtual		**Capability**	
		Percent of planning done with Decision Aids	Number of survivability plans determined with Decision Aids	Event Report PDU
			Number of survivability plans determined without Decision Aids	Event Report PDU
			Crew comments on survivability plans determined with and without Decision Aids	X
		Percent of monitoring done with Decision Aids	Number of monitoring actions conducted with Decision Aids	Event Report PDU
			Number of monitoring actions conducted without Decision Aids	Event Report PDU
			Crew comments on monitoring actions conducted with and without Decision Aids	X
		Percent of execution done with Decision Aids	Number of survivability actions executed with Decision Aids	Event Report PDU
			Number of survivability actions executed without Decision Aids	Event Report PDU
			Crew comments on survivability actions executed with and without Decision Aids	X
Survivability Subsystem. The Survivability Subsystem comprises all passive and active measures related to protecting the FARV crew and hardware systems. It interfaces heavily with the MMCS, and to differing extents, with all other subsystems.	Live or Virtual		**Time**	
		Average time passive measures activated	Time passive measure implemented	Event Report or Electromagnetic Emissions PDU
			Time passive measure completed	Event Report or Electromagnetic Emissions PDU
			Passive measure implemented	Event Report or Electromagnetic Emissions PDU
		Average time active measures activated	Time active measure implemented	Event Report or Electromagnetic Emissions PDU
			Time active measure completed	Event Report or Electromagnetic Emissions PDU
			Active measure implemented	Event Report or Electromagnetic Emissions PDU

Subject of Experimentation/Testing: FARV Secondary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Firepower (Defensive). The system defensive armament shall provide for area suppression and defensive capability employable against threat ground forces, helicopters, reconnaissance vehicles and other lightly armored targets that fall within close-combat range.	Live or Virtual		**Capability**	
		Percent of effective engagements with secondary armament	Number of target engagements	Event Report PDU
			Number of targets defeated	Entity State PDU
			Type of force/vehicle engaged	Event Report PDU
			Range at which target was engaged	Entity State PDU
			Engagement with primary or secondary armament	Event Report PDU
			Effectiveness	
		Effectiveness of secondary armament	Number of rounds/missiles fired	Fire PDU
			Number of target hits	Detonation PDU
			Range at which target hits occurred	Fire and Detonation PDU
			Type of force/vehicle engaged	Entity State PDU
Defensive Armament. The defensive armament for the system shall be a combat instrument capable of engaging targets at close combat range.	Live or Virtual		**Capability**	
			Minimum effective and safe range	
			Maximum effective range	
			Maximum sustained rate of fire	
			Maximum rate of fire	
			Number of on-board rounds/missiles	Event Report PDU
			Range	
		Average engagement range	Distance at which target first engaged	Entity State PDU
			Distance at which target defeated or disengaged	Entity State PDU
			Time	
			Time engagement stopped	Event Report PDU
			Time engagement started	Event Report PDU

Subject of Experimentation/Testing: FARV Secondary Armament

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Safety. Firing the defensive weapon shall not introduce toxic products into the crew compartment in concentrations that exceed OSHA established limits.	Live or Virtual		**Capability**	
		Percent of warnings related to firing secondary armament	Record of firing the secondary armament	Fire PDU
			Record of warnings attributed to firing the secondary armament	Event Report PDU
The C3 Subsystem shall include capabilities to support the crew in monitoring system safety status.			Vehicle ID number	Entity State PDU
			Record of operator monitoring of safety status actions	Event Report PDU
			Record of operator safety status actions taken	Event Report PDU
			Reason for taking action	Event Report PDU
The system shall provide both audible and visible warnings to alert the crew to internal and external hazardous situations, e.g., fire, NBC contamination, LP spills, and vehicle backing up. These warnings shall not interrupt mission critical functions or create unsafe situations in tactical environments.			Number of warnings to alert crew	Event Report PDU
			Type of alert (audible, visual or both)	Event Report PDU
			Reason for warning	Event Report PDU
			Number of warnings that interrupted mission critical functions	Event Report PDU
Power.	Live and Virtual		**Capability**	
The FARV must be able to produce a reduced level of power which is capable of powering on-board computer, communications, position/navigation and survivability systems (secondary armament and NBC overpressure) and starting the engine for at least 6 hours.			Record of reduced power operations of the survivability subsystem Record of reduced power operations for the survivability sensors systems	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
		Median Time Reduced Power Level Operations were Conducted	**Time** Time reduced power level operations stopped Time reduced power level operations initiated Record of reduced power level operations Reason for reduced power level operations	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
Identification Friend or Foe (IFF). The C3 Subsystem shall use standard Battlefield Combat Identification System procedures and equipment to reduce the potential for fratricide.	Live or Virtual		**Capability**	
			Record of BCIS use	Event Report PDU
			Problems encountered with IFF identification	Event Report PDU
			Accuracy	
		Percent correct IFF replies	Number of IFF queries	Signal PDU
			Number of IFF successful replies	Signal PDU

Subject of Experimentation/Testing: FARV Secondary Armament

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow demonstration and evaluation of various secondary armament weapon capabilities. The system could be looked at for integration of automation, ammunition storage capacity, self-defense decision aid execution and operator controls/displays. Assessment of the adequacy, maturity and compatibility of the secondary armament system to defeat threat targets could be made. The evaluation and selection of alternative technologies could also be made in the areas of effectiveness, efficiency, survivability ratios and hit probabilities. The technical characteristics of each weapon system could be assessed in terms of rates of fire, effective ranges and probability of hit and kill in an operational environment.

2.1 Stated specifications:

- Decision Aids
- Survivability Subsystem
- Firepower (Defensive)
- Defensive Armament
- Safety
- Identification Friend or Foe (IFF)

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the FARV System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains threat air and ground forces, FARV engagement of these systems could occur. Crew reactions, crew tasks, timeline analysis, weapon engagements and results could be gathered and the results assessed by different type of secondary armament system employed to determine the best solution to the secondary armament weapon. This sequence of events could evaluate the overall impact on system and crew's capability to meet battlefield, system and secondary armament system requirements. Placing the FARV simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the FARV specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Ranges for engagement of threat targets
- Effectiveness of engagements
- Survivability of the FARV following ground engagement
- Survivability of the FARV following air engagement
- Effectiveness of active and passive measures
- Reduction of fratricide instances
- Effectiveness of Decision Aids to increase system survivability
- Effectiveness of multiple engagements when operating under single. paired and pooled operations

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One FARV crew to man an FARV simulator
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update FARV information base on LRP locations, resupply requests and operations and battlefield information.
- Four AFAS and three FARV SAFOR to support paired and pooled self-defense operations
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order
- Threat ground and air vehicles and systems to conduct target engagements
- A Time Ordered Events List (TOEL)

Subject of Experimentation/Testing: AFAS Decision Aid-Fire Mission Processing

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Firepower. The AFAS will provide responsive indirect fire to the maneuver forces. High speed automated firing data computation, advanced propulsion technology, and automated ammunition handling, loading and firing will enable the AFAS to deliver massive and precise firepower as part of coordinated unit missions or independent single howitzer missions. The Fire Mission Processing (FMP) Decision Aid (DA) manages the AFAS ballistic computation component (BCC), providing fire missions to the BCC from a prioritized, time-sequenced mission queue. Therefore, the measures of performance do not address the technical fire control issues or compliance with Fire Support Coordination Measures, both tasks belonging to the BCC.	Virtual or Live	Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
Command, Control and Communications (C^3). The system shall be capable of centralized, decentralized and senior/subordinate modes of operation.	Virtual or Live	**For each mode of operation:**		
		Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
		Total time required to execute each fire mission while in position, with and without DA		Event report PDU
		Total time required to execute each fire mission while moving, with and without DA		Event report PDU

Subject of Experimentation/Testing: AFAS Decision Aid–Fire Mission Processing

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the FMP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X
Responsiveness. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the system's responsiveness is affected by the crew's ability to respond rapidly to the next priority mission request. The required response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	Total number of rounds fired, with and without DA Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA Time fired and sequence of missions fired with fire order components listed, with and without DA Total time required to execute each fire mission while in position, with and without DA Total time required to execute each fire mission while moving, with and without DA		Fire PDU or Signal PDU (MFRs) Signal PDU Signal PDU Fire PDU and Event report PDU Event report PDU Event report PDU

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. Required Resources. Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: AFAS Decision Aid-Reconnaissance, Selection and Occupation of Position (RSOP)

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The AFAS must optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. The RSOP decision aid contains route planning, navigation and firing site selection capabilities that facilitate crew performance evaluation in a simulation environment with and without the decision-aid capability. The RSOP decision aid contains algorithms and rules that help crew members by automatically considering threat line of sight, communications line of sight and other tactical considerations involving digital terrain elevation data; and other factors that use Digital Mapping Agency standard terrain overlay information to automatically evaluate routes and firing sites without the crew's having to conduct reconnaissance or lengthy paper map analyses.	Virtual or Live	Route Planning and Site Selection Time, Accuracy and Completeness Number of howitzer moves Number of rounds delivered on target Number of howitzers surviving	Time automated route-selection speed •Manual route-selection speed •Automated site-selection speed •Manual site-selection speed Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected sites acceptable according to the completeness criteria?	This would require event report PDUs of time of route-selection start and stop. Entity state PDU Detonation PDU Entity state PDU Determined through post-exercise analysis

Subject of Experimentation/Testing: AFAS Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles Did computer-selected and manually selected sites consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Recent use of the firing position (Counterfire) •Coverage of howitzer area of responsibility •Slope •Surface conditions •Threat	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the RSOP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

Subject of Experimentation/Testing: AFAS Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the system's responsiveness is affected by the speed with which it executes "shoot and scoot" tactics. The required response time while in position is only within 20 seconds; the response time while moving is within 45 seconds. The more quickly the crew can execute its frequent survivability moves, the more quickly the howitzer will be back in position for more rapid response. Since the RSOP decision aid reduces planning time and rapidly provides the most acceptable routes and sites, it positively influences system responsiveness.	Virtual or Live	Route Planning and Site Selection Time, Accuracy and Completeness	Time • Automated route-selection speed • Manual route-selection speed • Automated site-selection speed • Manual site-selection speed	This would require event report PDUs of time of route-selection start and stop.
		Number of howitzer moves		Entity state PDU
		Number of rounds delivered on target		Detonation PDU
		Number of howitzers surviving		Entity state PDU
			Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected sites acceptable according to the completeness criteria?	Determined through post-exercise analysis

Subject of Experimentation/Testing: AFAS Decision Aid–Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Overhead concealment •Overhead clearance •*Time to complete movement* •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles Did computer-selected and manually selected sites consider the following criteria? •NBC contamination •Entries and exits •*Proximity to friendly units* •Communications line of sight with higher headquarters and observers •Recent use of the firing position (Counterfire) •Coverage of howitzer area of responsibility •Slope •Surface conditions •Threat	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

Subject of Experimentation/Testing: AFAS Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply. To enhance system effectiveness and responsiveness and increase the survivability of both the FARV and the AFAS, the primary means of AFAS Class III (fuel) and Class V (primary armament ammunition) resupply will be automated and provided under armor by the FARV. Rapid, automated transfer operations will allow the AFAS to receive ready-to-fire fuzed projectiles, eliminating manual ammunition processing and handling requirements under normal AFAS operations. Other classes of supply may be manually supplied by the FARV or by other means. The AFAS will use embedded decision aids to assist the crew in managing on-board inventories and resupply training.	Virtual and Live	Route Planning and LRP-Selection Time, Accuracy and Completeness	**Time** •Automated route-selection speed •Manual route-selection speed •Automated site-selection speed •Manual site-selection speed	This would require event report PDUs of time of route-selection start and stop.
		Number of howitzer moves		Entity state PDU
		Number of rounds delivered on target		Detonation PDU
		Number of howitzers surviving		Entity state PDU
			Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected sites acceptable according to the completeness criteria?	Determined through post-exercise analysis

Subject of Experimentation/Testing: AFAS Decision Aid–Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles Did computer-selected and manually selected sites consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Recent use of the firing position (Counterfire) •Coverage of howitzer area of responsibility •Slope •Surface conditions •Threat	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. **Required Resources.** Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: AFAS Decision Aid-Self Defense

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Firepower. AFAS will provide responsive indirect fire to the maneuver forces. High speed automated firing data computation, advanced propulsion technology and automated ammunition handling, loading and firing will enable the AFAS to deliver massive and precise firepower as part of coordinated unit missions or independent single howitzer operations.	Virtual or Live	Number of Charge 2/3 self-defense rounds fired (killer junior), with and without DA	A 2 or 3 in the Charge field of a Mission Fired Report defines a self-defense round.	Signal PDU
Survivability. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the AFAS must create a self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	Number of survivability moves, with and without DA (750 meters or less) Number of AFASs that survive, with and without DA Number of enemy contact reports, with and without DA Number of Battle Damage Assessment Reports, with and without DA Range of threat at sensor detection time, with and without DA Number of threat detections by sensor type, with and without DA Rounds fired in each position area, with and without DA Total number of rounds fired, with and without DA Number of Charge 2/3 self-defense rounds fired (killer junior)	**Possible Sensor Types** •Radar •Infrared •Acoustic •Magnetic •Visual (Video camera) •Near Infrared •Optical Augmentation •Electro-Magnetic (Radio) **Kinds of FARV Signatures** •Infrared •¶Movement •Noise •Radio Transmissions •Electromagnetic •Radiation •Visible Light •Incidental Signatures **Sources of threat information** •On-board sensors •Intelligence reports (displayed on FARV digital map)	Entity state PDU Entity state PDU Signal PDU Signal PDU Event report PDU Event report PDU Fire PDU or Signal PDU (MFR) Signal PDU (MFR)

Subject of Experimentation/Testing: AFAS Decision Aid--Self Defense

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the SD decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. **Required Resources.** Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: AFAS Decision Aid-Sustainment

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply. The AFAS Sustainment decision aid (DA) will provide performance support in the areas of maintenance management, inventory control, records management, requisitioning and the creation and maintenance of crew rotation schedules. Applicable functions apply to all classes of supply.	Virtual or Live	Total quantity of each class of supply delivered, with and without DA Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without DA Total number times the AFAS rendered non-operational because of the lack of a class of supply, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA Total number of missions fired, with and without DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Event report PDU Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: AFAS Decision Aid--Sustainment

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Command, Control and Communications (C^3). The system shall be capable of centralized and decentralized modes of operation to provide a broad spectrum of communications capabilities.	Virtual or Live	**For each mode of operation:** Total quantity of each class of supply delivered, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA	**Classes of Supply:** I Subsistence II Clothing, individual equipment, tentage, *tool sets, tool kits*, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	 Event report PDU Signal PDU
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the FMP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X

Subject of Experimentation/Testing: AFAS Decision Aid--Sustainment

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the AFAS's responsiveness is affected by its ability to maintain and resupply itself. The required AFAS fire mission response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	AFAS fire mission response time, with and without DA Total quantity of each class of supply delivered, with and without DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without DA Total number times the AFAS rendered non-operational because of the lack of a class of supply, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Signal PDU and Fire PDU Event report PDU Signal PDU Signal PDU Signal PDU

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. Required Resources. Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: AFAS Decision Aid-Embedded Training (ET) and ET During System Operations

Note: ET must be used in conjunction with the other components of the integrated decision enhancement system (DES). ET will not operate by itself to support crew manual operations. In addition, only the performance support component of ET can be evaluated in a virtual or live environment; therefore, the variables "ET during system operations" and "ET decision aid" are synonymous.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Firepower. The AFAS will provide responsive indirect fire to the maneuver forces. High speed automated firing data computation, advanced propulsion technology, and automated ammunition handling, loading and firing will enable the AFAS to deliver massive and precise firepower as part of coordinated unit missions or independent single howitzer missions. The ET decision aid (DA) will provide over-the-shoulder coaching and just-in-time help, the performance support component of the ET requirement, which should improve crew performance in each major mission area.	Virtual or Live	Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
Command, Control and Communications (C^3). The system shall be capable of centralized, decentralized and senior/subordinate modes of operation.	Virtual or Live	**For each mode of operation:**		
		Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
		Total time required to execute each fire mission while in position, with and without DA		Event report PDU
		Total time required to execute each fire mission while moving, with and without DA		Event report PDU

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the FMP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X
Survivability in Route Planning and Site Selection. The AFAS must optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. The RSOP decision aid contains route planning, navigation and firing site selection capabilities that facilitate crew performance evaluation in a simulation environment with and without the decision-aid capability. The RSOP decision aid contains algorithms and rules that help crew members by automatically considering threat line of sight, communications line of sight and other tactical considerations involving digital terrain elevation data; and other factors that use Digital Mapping Agency standard terrain overlay information to automatically evaluate routes and firing sites without the crew's having to conduct reconnaissance or lengthy paper map analyses.	Virtual or Live	Route Planning and Site Selection Time, Accuracy and Completeness Number of howitzer moves Number of rounds delivered on target Number of howitzers surviving	Time •Automated route-selection speed •Manual route-selection speed •Automated site-selection speed •Manual site-selection speed Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected sites acceptable according to the completeness criteria?	This would require event report PDUs of time of route-selection start and stop. Entity state PDU Detonation PDU Entity state PDU Determined through post-exercise analysis

Subject of Experimentation/Testing: AFAS Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			Completeness Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

Subject of Experimentation/Testing: AFAS Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	*Measures of Performance*	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			**Completeness (continued)** Did computer-selected and manually selected sites consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Recent use of the firing position (Counterfire) •Coverage of howitzer area of responsibility •Slope •Surface conditions •Threat	

Subject of Experimentation/Testing: AFAS Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability in Self Defense. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the AFAS must create a self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	Number of survivability moves, with and without DA Number of AFASs that survive, with and without DA Number of enemy contact reports, with and without DA Number of Battle Damage Assessment Reports, with and without DA Range of threat at sensor detection time, with and without DA Number of threat detection's by sensor type, with and without DA Rounds fired in each position area, with and without DA Total number of rounds fired, with and without DA Number of Charge 2/3 self-defense rounds fired (killer junior)	**Possible Sensor Types** •Radar •Infrared •Acoustic •Magnetic •Visual (Video camera) •Near Infrared •Optical Augmentation •Electro-Magnetic (Radio) **Kinds of FARV Signatures** •Infrared •¶Movement •Noise •Radio Transmissions •Electromagnetic •Radiation •Visible Light •Incidental Signatures **Sources of threat information** •On-board sensors •Intelligence reports (displayed on FARV digital map)	Entity state PDU Entity state PDU Signal PDU Signal PDU Event report PDU Event report PDU *Fire PDU or Signal PDU (MFR)* Signal PDU (MFR)

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in Fire Mission Processing. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the system's responsiveness is affected by the crew's ability to respond rapidly to the next priority mission request. The required response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
		Total time required to execute each fire mission while in position, with and without DA		Event report PDU
		Total time required to execute each fire mission while moving, with and without DA		Event report PDU

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in Route Planning and Site Selection. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the system's responsiveness is affected by the speed with which it executes "shoot and scoot" tactics. The required response time while in position is only within 20 seconds; the response time while moving is within 45 seconds. The more quickly the crew can execute its frequent survivability moves, the more quickly the howitzer will be back in position for more rapid response. Since the RSOP decision aid reduces planning time and rapidly provides the most acceptable routes and sites, it positively influences system responsiveness.	Virtual or Live	Route Planning and Site Selection Time, Accuracy and Completeness Number of howitzer moves Number of rounds delivered on target Number of howitzers surviving	**Time** •Automated route-selection speed •Manual route-selection speed •Automated site-selection speed •Manual site-selection speed **Accuracy** Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected sites acceptable according to the completeness criteria?	This would require event report PDUs of time of route-selection start and stop. Entity state PDU Detonation PDU Entity state PDU Determined through post-exercise analysis

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles	

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness (continued)			**Completeness (continued)** Did computer-selected and manually selected sites consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Recent use of the firing position (Counterfire) •Coverage of howitzer area of responsibility •Slope •Surface conditions •Threat	

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in Sustainment Operations. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the AFAS's responsiveness is affected by its ability to maintain and resupply itself. The required AFAS fire mission response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	*AFAS fire mission response time, with and without DA* Total quantity of each class of supply delivered, with and without DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without DA Total number times the AFAS rendered non-operational because of the lack of a class of supply, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA	*Classes of Supply:* I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	*Signal PDU and Fire PDU* Event report PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: AFAS Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (Route Planning and Site Selection). To enhance system effectiveness and responsiveness and increase the survivability of both the FARV and the AFAS, the primary means of *AFAS Class III (fuel)* and *Class V* (primary armament ammunition) resupply will be automated and provided under armor by the FARV. Rapid, automated transfer operations will allow the AFAS to receive *ready-to-fire fuzed* projectiles, eliminating manual ammunition processing and handling requirements under normal AFAS operations. Other classes of supply may be manually supplied by the FARV or by other means. The AFAS will use embedded decision aids to assist the crew in managing on-board inventories and resupply training.	Virtual and Live	Route Planning and LRP-Selection Time, Accuracy and Completeness *Number of howitzer* moves Number of rounds delivered on target Number of howitzers *surviving*	Time •Automated route-selection speed •*Manual* route-selection speed •Automated site-selection speed •Manual site-selection speed Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected sites acceptable according to the completeness criteria?	This would require event report PDUs of time of route-selection start and stop. Entity state PDU Detonation PDU Entity state PDU Determined through post-exercise analysis

Subject of Experimentation/Testing: AFAS Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Entries and exits •*Proximity to friendly units* •Communications line of sight with higher headquarters and observers •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles	

Subject of Experimentation/Testing: AFAS Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (continued)			**Completeness (continued)** Did computer-selected and manually selected sites consider the following criteria? •NBC contamination •Entries and exits •Proximity to friendly units •Communications line of sight with higher headquarters and observers •Recent use of the firing position (Counterfire) •Coverage of howitzer area of responsibility •Slope •Surface conditions •Threat	

Subject of Experimentation/Testing: AFAS Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (Sustainment). The AFAS Sustainment decision aid (DA) will provide performance support in the areas of maintenance management, inventory control, records management, requisitioning and the creation and maintenance of crew rotation schedules. Applicable functions apply to all classes of supply.	Virtual or Live	Total quantity of each class of supply delivered, with and without DA Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without DA Total number times the AFAS rendered non-operational because of the lack of a class of supply, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA Total number of missions fired, with and without DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Event report PDU Signal PDU Signal PDU Signal PDU Signal PDU

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. **Required Resources.** Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: FARV Decision Aid-Mission Management

Note: FARV Mission Management includes the sustainment functions listed separately for the AFAS.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply. The FARV will provide AFAS with automated, under armor Class III (fuel) and Class V (primary armament ammunition). Rapid, automated transfer operations will allow the system to rearm AFAS with ready-to-fire fuzed projectiles, LP and fuel, eliminating manual ammunition processing and handling requirements under normal FARV/AFAS operations. Other classes of supply may be manually supplied to AFAS. The system will use embedded decision aids to assist the crew in managing on-board inventories and resupply planning.	Virtual or Live	Total quantity of each class of supply delivered, with and without MM DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without MM DA Total number times the FARV rendered non-operational because of the lack of a class of supply, with and without MM DA Number of maintenance and resupply reports sent to the POC and LRP, with and without MM DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Event report PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Decision Aid--Mission Management

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Command, Control and Communications (C^3). The system shall be capable of centralized and decentralized modes of operation to provide a broad spectrum of communications capabilities.	Virtual or Live	**For each mode of operation:** Total quantity of each class of supply delivered, with and without MM DA Number of maintenance and resupply reports sent to the POC and LRP, with and without MM DA	**Classes of Supply:** I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Event report PDU Signal PDU
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the FMP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X

Subject of Experimentation/Testing: FARV Decision Aid--Mission Management

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the AFAS's responsiveness is affected by the FARV's ability to resupply. The required AFAS fire mission response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	AFAS fire mission response time, with and without MM DA Total quantity of each class of supply delivered, with and without MM DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without MM DA Total number times the FARV rendered non-operational because of the lack of a class of supply, with and without MM DA Number of maintenance and resupply reports sent to the POC and LRP, with and without MM DA	**Classes of Supply:** I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Signal PDU and Fire PDU Event report PDU Signal PDU Signal PDU Signal PDU

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. Required Resources. Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: FARV Decision Aid-Reconnaissance, Selection and Occupation of Position (RSOP)

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The FARV must optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. The RSOP decision aid contains route planning, navigation and LRP selection capabilities that facilitate crew performance evaluation in a simulation environment with and without the decision-aid capability. The RSOP decision aid contains algorithms and rules that help crew members by automatically considering threat line of sight, communications line of sight and other tactical considerations involving digital terrain elevation data; and other factors that use Digital Mapping Agency standard terrain overlay information to automatically evaluate routes and LRPs without the crew's having to conduct reconnaissance or lengthy paper map analyses.	Virtual or Live	Route Planning and LRP-Selection Time, Accuracy and Completeness	Time •Automated route-selection speed •Manual route-selection speed •Automated LRP-selection speed •Manual LRP-selection speed	This would require event report PDUs of time of route-selection start and stop.
		Number of FARV moves		Entity state PDU
		Number of rounds delivered		Resupply received PDU
		Number of FARVs surviving		Entity state PDU
			Accuracy	Determined through post-exercise analysis
			Were the computer-selected and manually selected routes navigable according to the completeness criteria?	
			Were the computer-selected and manually selected LRPs acceptable according to the completeness criteria?	

Subject of Experimentation/Testing: FARV Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles Did computer-selected and manually selected LRPs consider the following criteria? •NBC contamination •Entries and exits •Dimensions of clearings •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Recent use of the LRP (Counterfire) •Slope •Surface conditions •Threat	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the RSOP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

Subject of Experimentation/Testing: FARV Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness. The responsiveness of the AFAS is affected by the responsiveness of the FARV to resupply requirements. The amount of time it takes to travel is a function of route planning and LRP selection time, as well as route "goodness." Since the RSOP decision aid reduces planning time and rapidly provides the most acceptable routes and LRPs, it positively influences both FARV and AFAS system responsiveness.	*Virtual or Live*	Route Planning and Site Selection Time, Accuracy and Completeness	Time •Automated route-selection speed •Manual route-selection speed •Automated LRP-selection speed •Manual LRP-selection speed	*This would require event report* PDUs of time of route-selection start and stop.
		Number of FARV moves		*Entity state PDU*
		Number of rounds delivered		Resupply received PDU
		Number of FARVs surviving		Entity state PDU
			Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected LRPs acceptable according to the completeness criteria?	Determined through post-exercise analysis

Subject of Experimentation/Testing: FARV Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles Did computer-selected and manually selected LRPs consider the following criteria? •NBC contamination •Entries and exits •Dimensions of clearings •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Recent use of the LRP (Counterfire) •Slope •Surface conditions •Threat	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

Subject of Experimentation/Testing: FARV Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply. The system shall automate storage, upload, download, rearm, exchange, transload and docking in providing fuel and primary armament munitions (except M712 Copperhead, which may be handled manually) to support the AFAS and to meet the performance requirements specified. The responsiveness of the AFAS is affected by the responsiveness of the FARV to resupply requirements. The amount of time it takes to travel is a function of route planning and LRP selection time, as well as route "goodness." Since the RSOP decision aid reduces planning time and rapidly provides the most acceptable routes and LRPs, it positively influences both FARV and AFAS system responsiveness.	Virtual and Live	Route Planning and LRP-Selection Time, Accuracy and Completeness	Time •Automated route-selection speed •Manual route-selection speed •Automated LRP-selection speed •Manual LRP-selection speed	This would require event report PDUs of time of route-selection start and stop.
		Number of FARV moves		Entity state PDU
		Number of rounds delivered		Resupply received PDU
		Quantity of fuel delivered		Entity state PDU
		Quantity of other classes of supply delivered	Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria?	Determined through post-exercise analysis
		Number of FARVs surviving	Were the computer-selected and manually selected LRPs acceptable according to the completeness criteria?	

Subject of Experimentation/Testing: FARV Decision Aid--Reconnaissance, Selection and Occupation of Position (RSOP)

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles Did computer-selected and manually selected LRPs consider the following criteria? •NBC contamination •Entries and exits •Dimensions of clearings •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Recent use of the LRP (Counterfire) •Slope •Surface conditions •Threat	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to *justify* the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. **Required Resources.** Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: FARV Decision Aid-Self Defense

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the FARV must create self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	Number of survivability moves, with and without DA (750 meters or less) Number of FARVs that survive, with and without DA Number of enemy contact reports, with and without DA Number of Battle Damage Assessment Reports, with and without DA Range of threat at sensor detection time, with and without DA Number of threat detection's by sensor type, with and without DA	**Possible Sensor Types** •Radar •Infrared •Acoustic •Magnetic •Visual (Video camera) •Near Infrared •Optical Augmentation •Electro-Magnetic (Radio) **Kinds of FARV Signatures** •Infrared •¶Movement •Noise •Radio Transmissions •Electromagnetic •Radiation •Visible Light •Incidental Signatures **Sources of threat information** •On-board sensors •Intelligence reports (displayed on FARV digital map)	Entity state PDU Entity state PDU Signal PDU Signal PDU Event report PDU Event report PDU
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the SD decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. **Required Resources.** Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: FARV Decision Aid-Embedded Training (ET) and ET During System Operations

Note: ET must be used in conjunction with the other components of the integrated decision enhancement system (DES). ET will not operate by itself to support crew manual operations. In addition, only the performance support component of ET can be evaluated in a virtual or live environment; therefore, the variables "ET during system operations" and "ET decision aid" are synonymous.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply in FARV Mission Management. The FARV will provide AFAS with automated, under armor Class III (fuel) and Class V (primary armament ammunition). Rapid, automated transfer operations will allow the system to rearm AFAS with ready-to-fire fuzed projectiles, LP and fuel, eliminating manual ammunition processing and handling requirements under normal FARV/AFAS operations. Other classes of supply may be manually supplied to AFAS. The system will use embedded decision aids to assist the crew in managing on-board inventories and resupply planning.	Virtual or Live	Total quantity of each class of supply delivered, with and without MM DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without MM DA Total number times the FARV rendered non-operational because of the lack of a class of supply, with and without MM DA Number of maintenance and resupply reports sent to the POC and LRP, with and without MM DA	**Classes of Supply:** I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Event report PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Command, Control and Communications (C^3) in AFAS Fire Mission Processing. The system shall be capable of centralized, decentralized and senior/subordinate modes of operation.	Virtual or Live	**For each mode of operation:**		
		Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
		Total time required to execute each fire mission while in position, with and without DA		Event report PDU
		Total time required to execute each fire mission while moving, with and without DA		Event report PDU

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Command, Control and Communications (C^3) in FARV Mission Management. The system shall be capable of centralized and decentralized modes of operation to provide a broad spectrum of communications capabilities.	Virtual or Live	**For each mode of operation:** Total quantity of each class of supply delivered, with and without MM DA Number of maintenance and resupply reports sent to the POC and LRP, with and without MM DA	**Classes of Supply:** I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	 Event report PDU Signal PDU
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the FMP decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability in Route Planning and Site Selection. The FARV must optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. The RSOP decision aid contains route planning, navigation and LRP selection capabilities that facilitate crew performance evaluation in a simulation environment with and without the decision-aid capability. The RSOP decision aid contains algorithms and rules that help crew members by automatically considering threat line of sight, communications line of sight and other tactical considerations involving digital terrain elevation data; and other factors that use Digital Mapping Agency standard terrain overlay information to automatically evaluate routes and LRPs without the crew's having to conduct reconnaissance or lengthy paper map analyses.	Virtual or Live	Route Planning and LRP-Selection Time, Accuracy and Completeness	Time	This would require event report PDUs of time of route-selection start and stop.
			•Automated route-selection speed	
		Number of FARV moves	•Manual route-selection speed	Entity state PDU
		Number of rounds delivered	•Automated LRP-selection speed	Resupply received PDU
		Number of FARVs surviving	•Manual LRP-selection speed	Entity state PDU
			Accuracy	Determined through post-exercise analysis
			Were the computer-selected and manually select. routes navigable according to the completeness criteria?	
			Were the computer-selected and manually selected LRPs acceptable according to the completeness criteria?	

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

Subject of Experimentation/Testing: FARV Decision Aid–Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			**Completeness (continued)** Did computer-selected and manually selected LRPs consider the following criteria? •NBC contamination •Entries and exits •Dimensions of clearings •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Recent use of the LRP (Counterfire) •Slope •Surface conditions •Threat	

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability in Self Defense. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the FARV must create self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	Number of survivability moves, with and without DA Number of FARVs that survive, with and without DA Number of enemy contact reports, with and without DA Number of Battle Damage Assessment Reports, with and without DA Range of threat at sensor detection time, with and without DA Number of threat detection's by sensor type, with and without DA	**Possible Sensor Types** •Radar •Infrared •Acoustic •Magnetic •Visual (Video camera) •Near Infrared •Optical Augmentation •Electro-Magnetic (Radio) **Kinds of FARV Signatures** •Infrared •¶Movement •Noise •Radio Transmissions •Electromagnetic •Radiation •Visible Light •Incidental Signatures **Sources of threat information** •On-board sensors •Intelligence reports (displayed on FARV digital map)	Entity state PDU Entity state PDU Signal PDU Signal PDU Event report PDU Event report PDU

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in Fire Mission Processing. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the system's responsiveness is affected by the crew's ability to respond rapidly to the next priority mission request. The required response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	Total number of rounds fired, with and without DA		Fire PDU or Signal PDU (MFRs)
		Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC), with and without DA		Signal PDU
		Number of fire missions returned as unsupportable to the POC for insufficient appropriate ammunition, with and without DA		Signal PDU
		Time fired and sequence of missions fired with fire order components listed, with and without DA		Fire PDU and Event report PDU
		Total time required to execute each fire mission while in position, with and without DA		Event report PDU
		Total time required to execute each fire mission while moving, with and without DA		Event report PDU

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in FARV Mission Management. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the AFAS's responsiveness is affected by the FARV's ability to resupply. The required AFAS fire mission response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	AFAS fire mission response time, with and without MM DA Total quantity of each class of supply delivered, with and without MM DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without MM DA Total number times the FARV rendered non-operational because of the lack of a class of supply, with and without MM DA Number of maintenance and resupply reports sent to the POC and LRP, with and without MM DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Signal PDU and Fire PDU Event report PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in Route Planning and Site Selection. The responsiveness of the AFAS is affected by the responsiveness of the FARV to resupply requirements. The amount of time it takes to travel is a function of route planning and LRP selection time, as well as route "goodness." Since the RSOP decision aid reduces planning time and rapidly provides the most acceptable routes and LRPs, it positively influences both FARV and AFAS system responsiveness.	Virtual or Live	Route Planning and Site Selection Time, Accuracy and Completeness Number of FARV moves Number of rounds delivered Number of FARVs surviving	Time •Automated route-selection speed •Manual route-selection speed •Automated LRP-selection speed •Manual LRP-selection speed Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected LRPs acceptable according to the completeness criteria?	This would require event report PDUs of time of route-selection start and stop. Entity state PDU Resupply received PDU Entity state PDU Determined through post-exercise analysis

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness (continued)			**Completeness (continued)** Did computer-selected and manually selected LRPs consider the following criteria? •NBC contamination •Entries and exits •Dimensions of clearings •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Recent use of the LRP (Counterfire) •Slope •Surface conditions •Threat	

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Responsiveness in Sustainment Operations. Though the AFAS is always available to shoot fire missions in support of the maneuver commander, i.e., while on the move or emplaced, the AFAS's responsiveness is affected by its ability to maintain and resupply itself. The required AFAS fire mission response time while in position is within 20 seconds; the response time while moving is within 45 seconds.	Virtual or Live	AFAS fire mission response time, with and without DA Total quantity of each class of supply delivered, with and without DA Total number of AFAS fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without DA Total number times the AFAS rendered non-operational because of the lack of a class of supply, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Signal PDU and Fire PDU Event report PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (Route Planning and Site Selection). The system shall automate storage, upload, download, rearm, exchange, transload and docking in providing fuel and primary armament munitions (except M712 Copperhead, which may be handled manually) to support the AFAS and to meet the performance requirements specified. The responsiveness of the AFAS is affected by the responsiveness of the FARV to resupply requirements. The amount of time it takes to travel is a function of route planning and LRP selection time, as well as route "goodness." Since the RSOP decision aid reduces planning time and rapidly provides the most acceptable routes and LRPs, it positively influences both FARV and AFAS system responsiveness.	Virtual and Live	Route Planning and LRP-Selection Time, Accuracy and Completeness	**Time** •Automated route-selection speed •Manual route-selection speed •Automated LRP-selection speed •Manual LRP-selection speed	This would require event report PDUs of time of route-selection start and stop.
		Number of FARV moves		Entity state PDU
		Number of rounds delivered		Resupply received PDU
		Quantity of fuel delivered		Entity state PDU
		Quantity of other classes of supply delivered		Entity state PDU
		Number of FARVs surviving		Entity state PDU
			Accuracy Were the computer-selected and manually selected routes navigable according to the completeness criteria? Were the computer-selected and manually selected LRPs acceptable according to the completeness criteria?	Determined through post-exercise analysis

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (continued)			**Completeness** Did computer-selected and manually selected routes consider the following criteria? •NBC contamination •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Overhead concealment •Overhead clearance •Time to complete movement •Fuel required to complete movement •Slope •Surface conditions •Threat •Military obstacles	These could be determined by post-exercise analysis of each of the bulleted items. Those items would all be readily available in the existing DIS versions with the exception of NBC and Fuel Required. Fuel required could be reported with an event report PDU. NBC contamination could be determined by analyzing NBC threats (represented as environmental entities).

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (continued)			**Completeness (continued)** Did computer-selected and manually selected LRPs consider the following criteria? •NBC contamination •Entries and exits •Dimensions of clearings •Proximity to friendly units •Communications line of sight with higher headquarters and AFASs •Recent use of the LRP (Counterfire) •Slope •Surface conditions •Threat	

Subject of Experimentation/Testing: FARV Decision Aid--Embedded Training (ET) and ET During System Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Resupply (Sustainment). The AFAS Sustainment decision aid (DA) will provide performance support in the areas of maintenance management, inventory control, records management, requisitioning and the creation and maintenance of crew rotation schedules. Applicable functions apply to all classes of supply.	Virtual or Live	Total quantity of each class of supply delivered, with and without DA Total number of fire missions returned as unsupportable to the Platoon Operations Center (POC) for each class of supply, with and without DA Total number times the AFAS rendered non-operational because of the lack of a class of supply, with and without DA Number of maintenance and resupply reports sent to the POC, LRP and FARV, with and without DA Total number of missions fired, with and without DA	Classes of Supply: I Subsistence II Clothing, individual equipment, tentage, tool sets, tool kits, hand tools, housekeeping supplies and equipment III Petroleum fuels IV Construction and barrier materials V Ammunition VI Personal demand items VII Major end items VIII Medical materials IX Repair parts and components	Event report PDU Signal PDU Signal PDU Signal PDU Signal PDU

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Though decision aids are no longer considered a high-risk technology by military leaders, they still need to quantify the operational benefit of various decision-aid prototypes to justify the research and development expense associated with them. Both virtual and live simulations offer the opportunity for side-by-side comparison testing of crews with and without these devices. The integration of decision aids also permits early soldier/user input as to how decision-aid performance might be improved. Ultimately, crews can be trained to better use fielded decision aids.

3. **Required Resources.** Decision-aid prototypes and interfaces, test and evaluation software to track decision-aid times and other variables, and, perhaps, video equipment to monitor crew performance.

Subject of Experimentation/Testing: AFAS Sensor Assets to Support Self Defense

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the AFAS must create a self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	**Number, kind, range, location and rate of advance of friendly and enemy (personnel, vehicular, air-delivered munition and aircraft) sensings from any of the following kinds of sensors projected for use on the AFAS:** •Radar •Infrared •Acoustic •Magnetic •Visual (Video camera) •Near Infrared •Optical Augmentation •Electro-Magnetic (Radio) •NBC	**Ground Attack Radar.** Will detect, identify and track personnel and wheeled and tracked vehicles out to a range of 5 km, line of sight (LOS) **Identification Friend or Foe (IFF).** A radar-based transmitter/receiver (transponder) system with a LOS-range of 10-12 km. Failure of target vehicle to recognize transmitted signal within 3 seconds results in assumption vehicle is unfriendly **Millimeter Wave Radar.** A passive sensor that detects presence of smart munitions and airborne radars out to a range of approximately 18 km.	The Emission PDU and Distributed Emission Regeneration can be used for simulating the SD sensor suite functions. However, NBC threats should be represented as environmental entities (Entity state PDU).
		Number of AFASs surviving, with and without each sensor or combination of sensors	**Laser Sensor.** Detects presence of transmitted laser energy on AFAS hull	Entity state PDU
		Number of AFAS BDAR reports, with and without each sensor or combination of sensors	**NBC Sensor.** Detects presence of all known NBC contaminants	Signal PDU
		Kinds of battle damage reported, with and without each sensor or combination of sensors		Signal PDU

Subject of Experimentation/Testing: AFAS Sensor Assets to Support Self Defense

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)			**Air Attack/Counterfire Sensor.** A radar-based sensor with two modes: external and internal. The external mode based on counterfire radar input of impact grid location of incoming indirect fire to the AFAS. The counterfire radar, itself, has a range of approx. 50 km LOS. The internal mode detects aircraft and counterfire rounds out to a range of 10 km LOS. **Acoustic Sensor.** Provides external ear, when AFAS buttoned up, out to a range of about 15 km for helicopter and aircraft engines. **Laser Range Finder.** Determines range out to about 10,000 meters. Tied to direct-fire mission.	
Survivability (continued)			**Television/IR Viewer.** IR for night operations. TV camera can be slaved to other sensors for visual confirmation with a 6400 mil observation, elevation min. -50 mils/max. +600 mils, day or night. **Radio.** The SINCGARS radio becomes a sensor for self defense insofar as it provides intelligence information and friendly disposition information.	
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the sensors controlled by the SD decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

2. ***Technical and Operational Benefits of Experimentation in DIS Virtual Environment.*** Planners have thus *far* collected *very* little data on the value of sensors on board the AFAS. By simulating detection or detecting the presence of friendly and enemy elements and attack munitions with varied combinations of sensors, these military planners can make supported judgments about which sensors provide the most value, and in which scenarios. Further, they can examine AFAS survivability rates with and without each of the sensors.

3. **Required Resources.** DIS PDUs that simulate the characteristic data collection capabilities of each of these sensors and actually report the presence of friendly and enemy elements, or actual integrated sensor suites used in live simulation.

Subject of Experimentation/Testing: FARV Sensor Assets to Support Self Defense

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the FARV must create a self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	**Number, kind, range, location and rate of advance of friendly and enemy (personnel, vehicular, air-delivered munition and aircraft) sensings from any of the following kinds of sensors projected for use on the FARV:** •Infrared •Acoustic •Magnetic •Visual (Video camera) •Near Infrared •Optical Augmentation •Electro-Magnetic (Radio) •NBC Number of FARVs surviving, with and without each sensor or combination of sensors Number of FARV BDAR reports, with and without each sensor or combination of sensors Kinds of battle damage reported, with and without each sensor or combination of sensors	**Identification Friend or Foe (IFF).** A radar-based transmitter/receiver (transponder) system with a LOS-range of 10-12 km. Failure of target vehicle to recognize transmitted signal within 3 seconds results in assumption vehicle is unfriendly ***Millimeter Wave Radar.*** A passive sensor that detects presence of smart munitions and airborne radars out to a range of approximately 18 km. **NBC Sensor.** Detects presence of all known NBC contaminants **Acoustic Sensor.** Provides external ear, when FARV buttoned up, out to a range of about 15 km for helicopter and aircraft engines. **Television/IR Viewer.** IR for night operations. TV camera can be slaved to other sensors for visual confirmation with a 6400 mil observation, elevation min. -50 mils/max. +600 mils, day or night.	The Emission PDU and Distributed Emission Regeneration can be used for simulating the SD sensor suite functions. However, NBC threats should be represented as environmental entities (Entity state PDU). Entity state PDU Signal PDU Signal PDU
Survivability (continued)			**Radio.** The SINCGARS radio becomes a sensor for self defense insofar as it provides intelligence information and friendly disposition information.	
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the sensors controlled by the SD decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Planners have thus far collected very little data on the value of sensors on board the FARV. By simulating detection or detecting the presence of friendly and enemy elements and attack munitions with varied combinations of sensors, these military planners can make supported judgments about which sensors provide the most value, and in which scenarios. Further, they can examine FARV survivability rates with and without each of the sensors.

3. **Required Resources.** DIS PDUs that simulate the characteristic data collection capabilities of each of these sensors and actually report the presence of friendly and enemy elements, or actual integrated sensor suites used in live simulation.

Subject of Experimentation/Testing: AFAS Countermeasures Suite
1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the AFAS must create a self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	Number of NBC casualties reported, with and without the NBC defense suite (for comparison testing with and without the NBC system on board)	**Countermeasure Elements:**	An NBC casualty would be reported via an event response PDU
		Number of AFAS interior decontamination operations reported, with and without NBC defensive suite (for comparison testing with and without the NBC system on board)	**NBC Defense Suite.** Detects presence of all known NBC contaminants and includes NBC detection, warning, filtration and environmental conditioning systems.	An interior decontamination operation would be reported via an event report PDU
		Time of activation of the NBC defensive suite	**Main Gun Direct Fire Suite.** The main gun works in conjunction with the laser range finder to support defensive operations controlled by the AFAS Chief of Section. Direct fire with the main gun can achieve a range of about 5km.	Event response PDU
		Number of direct-fire hits, with and without SD DA and laser range finder support of the main gun		Detonation PDU
		Number of 20/30mm kills, with and without SD DA support		Detonation PDU

Subject of Experimentation/Testing: AFAS Countermeasures Suite

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability (continued)		Number of AFASs surviving, with and without each countermeasure element or combination of countermeasure elements Number of AFAS BDAR reports, with and without each countermeasure element or combination of countermeasure elements Kinds of battle damage reported, with and without each countermeasure element or combination of countermeasure elements Type and characteristics of enemy munition causing damage.	**Secondary Armament.** The 20 or 30 mm machine-gun (cannon) will provide additional direct-fire capability to a range of about 1 km. It operates with the laser range finder also. **Smoke Grenade Launcher/Generator.** The smoke grenade launcher is tied to the SD DA, launching defensive smoke whenever the engine is not running. When engine is running, a separate smoke generator will produce defensive smoke. Both systems generate an immediate cloud of radius 25 m in 5 sec., 50 m in 10 sec., 75 m in 15 sec., and 100m in 20 sec. Systems may be used together to generate a larger cloud. **Chaff Launcher.** The chaff launcher provides radar clutter to confuse or defeat microwave radar, or confuse laser-homing guided munitions and other types of sensor-fuzed weapons. The launcher creates a chaff bubble of 100m diameter in 2 sec. The SD DA will determine when to fire the second and succeeding rounds, if necessary.	Entity state PDU Signal PDU Signal PDU Detonation PDU
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the countermeasure components controlled by the SD decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Planners have thus far collected very little data on the value of countermeasure elements on board the AFAS. By simulating defensive and offensive operations with varied combinations of countermeasure elements, these military planners can make supported judgments about which countermeasure elements provide the most value, and in which scenarios. Further, they can examine AFAS survivability rates with and without each of the countermeasure elements.

3. **Required Resources.** DIS PDUs that simulate the characteristic effects of each of these countermeasure elements and actually report the enemy and friendly casualties and vehicular damage, or lack thereof. Actual countermeasure elements can also be used in live simulation.

Subject of Experimentation/Testing: FARV Countermeasures Suite
1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Survivability. The system will optimize its probability of survival via tactics and appropriate susceptibility and vulnerability reduction measures. Decision aids will assist the crew in planning and conducting system survivability operations by providing recommendations for responses to counteract identified threats. To survive, the FARV must create a self-defense plan, monitor and control its own signatures and activities, and monitor threat activity, ultimately choosing to stay and fight the threat, or run or hide from it.	Virtual or Live	Number of NBC casualties reported, with and without the NBC defense suite (for comparison testing with and without the NBC system on board) Number of FARV interior decontamination operations reported, with and without NBC defensive suite (for comparison testing with and without the NBC system on board) Time of activation of the NBC defensive suite Number of 20/30mm kills, with and without SD DA support	**Countermeasure Elements:** **NBC Defense Suite.** Detects presence of all known NBC contaminants and includes NBC detection, warning, filtration and environmental conditioning systems. **Secondary Armament.** The 20 or 30 mm machine-gun (cannon) will provide additional direct-fire capability to a range of about 1 km. It operates with the laser range finder also.	An NBC casualty would be reported via an event response PDU An interior decontamination operation would be reported via an event report PDU Event response PDU Detonation PDU Detonation PDU
Survivability (continued)		Number of FARVs surviving, with and without each countermeasure element or combination of countermeasure elements Number of FARV BDAR reports, with and without each countermeasure element or combination of countermeasure elements Kinds of battle damage reported, with and without each countermeasure element or combination of countermeasure elements Type and characteristics of enemy munition causing damage.	**Smoke Grenade Launcher/Generator.** The smoke grenade launcher is tied to the SD DA, launching defensive smoke whenever the engine is not running. When engine is running, a separate smoke generator will produce defensive smoke. Both systems generate an immediate cloud of radius 25 m in 5 sec., 50 m in 10 sec., 75 m in 15 sec., and 100m in 20 sec. Systems may be used together to generate a larger cloud. **Chaff Launcher.** The chaff launcher provides radar clutter to confuse or defeat microwave radar, or confuse laser-homing guided munitions and other types of sensor-fuzed weapons. The launcher creates a chaff bubble of 100m diameter in 2 sec. The SD DA will determine when to fire the second and succeeding rounds, if necessary.	Entity state PDU Signal PDU Signal PDU Detonation PDU

Subject of Experimentation/Testing: FARV Countermeasures Suite

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation of the countermeasure components controlled by the SD decision aid. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X

2. **Technical and Operational Benefits of *Experimentation in DIS Virtual Environment*.** *Planners* have thus far collected very little data on the value of countermeasure elements on board the FARV. By simulating defensive and offensive operations with varied combinations of countermeasure elements, these military planners can make supported judgments about which countermeasure elements provide the most value, and in which scenarios. Further, they can examine FARV survivability rates with and without each of the countermeasure elements.

3. **Required Resources.** DIS PDUs that simulate the characteristic effects of each of these countermeasure elements and actually report the enemy and friendly casualties and vehicular damage, or lack thereof. Actual countermeasure elements can also be used in live simulation.

Subject of Experimentation/Testing: AFAS Firing Position

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Firing Position Parameters Tube QE -3 to +75 Degrees from vehicle centerline.	Live Test	Can gun tube be elevated or depressed to the specified limits? Can the gun be fired at every combination of elevation, deflection and terrain slope without damage to the system or loss of accuracy?	Combination of quadrant of elevation, azimuth, charge, and ground slope at the firing position. Collect static and dynamic loads on the vehicle and vehicle suspension for each combination of charge, azimuth of fire, elevation and slope.	X X
Firing Position Parameters Terrain Slope -10 to +10 Degree Maximum resultant slope.	Virtual	Targets can be successfully engaged at all ranges from all slopes from -10 degrees to +10 degrees.	Terrain Slope. Azimuth to the target. Quadrant of elevation for the gun. Charge/distance to the target. Determined target location. Place round should hit. Place where round did hit. Numbers of rounds fired.	Event report PDU Event report PDU Event report PDU Event report PDU Detonation PDU Detonation PDU Detonation PDU Detonation PDU
Rearm Vehicle Mis-alignment Allowances. 10 degree maximum resultant angle between vehicles	Live	Can the AFAS be rearmed at every combination of resultant terrain slope without damage to the system or loss of automatic rearm capability?	Terrain slope. Resultant angle between both vehicles. Time resupply started. Time resupply ended. Amount of supplies transferred.	Event report PDU Entity state PDU Event report PDU Event report PDU Entity state PDU

Subject of Experimentation/Testing: AFAS Firing Position

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
Rearm Position Parameters Slopes <= 60% longitudinal and <=40% lateral	Live	Can the AFAS be rearmed at degree of terrain slope without damage to the system or loss of automatic rearm capability within the values specified in the first column?	Terrain slope.	Event report PDU
			Resultant angle between both vehicles.	Entity state PDU
			Time resupply started.	Event report PDU
			Time resupply ended.	Event report PDU
			Amount of supplies transferred.	Entity State PDU

X(1). **Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.**

2. **Technical and Operational Benefits of Experimentation with Firing and Rearm Position Parameters.**

2.1 **Stated specifications.** The AFAS will be able to aim and fire the primary weapon from terrain with slopes of -10° to +10°. The gun tube can be elevated to +75°, or depressed to -3° relative to the horizontal centerline if the vehicle. The AFAS and FARV will be able to exchange ammunition, fuel and propellant without any of the crew from either vehicle leaving the crew cabs of their respective vehicles, with a misalignment between vehicles of 10° or less.

2.2 **Other Aspects of Performance Measurable in a DIS Virtual Environment.** N/A.

2.3 **Sample Experiment.** *There are several types of experiments that can be accomplished either in softwar... DIS environment or a combination of the two. A single* experiment/scenario in the DIS virtual environment can address each of the specifications of performance outlined ... Analysts and testers can run the same experiment repeatedly, incrementally altering designs to determine operational and technical tradeoffs offered by alternative crew station configurations, soldier-machine interfaces (SMIs), BCC designs, and autoloading designs/times.

For example, if the autoloader emulation software has an interactive, selectable autoloading time, the impact of various autoloading designs on overall mission response time and rate of fire requirements may be determined.

Installation of a virtual ammunition transfer and autoloader prototype in the AFAS simulator provides the opportunity to experiment with various SMIs, software design architectures, and component capabilities to determine the best fit to meet overall response time and rate of fire requirements. If the fidelity of the ammunition transfer and autoloader is high enough, the tester could investigate the ability of the system to transfer ammunition when the AFAS and FARV are situated on terrain that have steep slopes.

Emulating the main gun tube elevation and traversing capabilities will allow the investigation into the combined effects of recoil and slope on stresses in the suspension system. If there are adverse effects, then the emulation software can be restricted so that there are no adverse effects and then determine the impact of the restrictions on mission effectiveness in a DIS scenario. The overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario.

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update AFAS information base on fire support coordination measures and battlefield geometry, meteorological data, and preplanned targets.
- One AFAS SAFOR to support senior to subordinate AFAS operations
- Threat SAFOR operations order
- Threat SAFOR to execute the order
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

4. **Emulators Required.** The following models or emulations will be needed to support the AFAS simulator.

1. Primary gun emulation packages consisting of models representing a traversing turret and transmission/electric/hydraulic tube elevating unit and aiming mechanism.
2. Primary chassis and suspension emulation packages consisting of models representing springs/torsion bars, road wheels, tracks and track pads.
3. Chassis model (in software) consisting of chassis, turret, gun tube, crew cab, etc. Primary interest in the DIS testing is in the chassis-gun tube configuration and interaction with the chassis when the gun is fired.

4. Ammunition transfer and loading system.

5. Power management system consisting of appropriate power sources, and control devices. Some of the devices must be crew accessible inside the simulator and will require a high fidelity emulation.

Subject of Experimentation/Testing: FARV Resupply Position Parameter Suitability

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Resupply Position Parameters	Virtual	Resupply transloading site selected allows transfer of ammunition without human handling.	Try different configurations of visibility, mating and ammunition handling equipment.	X(1).
FARV/AFAS Vehicle Mis-alignment Allowances. 10 degree maximum resultant angle between vehicles	Virtual	Can the supplies and ammunition be loaded or transferred at every combination of terrain and resultant angle between the vehicles within the specified limits without loss of system efficiency?	Responsiveness, Terrain Utilization Terrain slope. Resultant angle between vehicles. Time transfer began. Time transfer completed. Number of rounds transferred. Amount of fuel and propellant transferred.	X(1) Event report PDU Entity state PDU Event report PDU Event report PDU Resupply report PDU Resupply report PDU
Slopes <= 60% longitudinal and <=40% lateral	Live	Can the FARV transload munitions and supplies at degree of terrain slope without damage to the system or loss of automatic rearm capability within the values specified in the first column?	Terrain slope. Resultant angle between vehicles. Time transfer began. Time transfer completed. Number of rounds transferred. Amount of fuel and propellant transferred.	Event report PDU Entity state PDU Event report PDU Event report PDU Resupply received PDU Resupply received PDU

X(1). *Note:* *DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.*

2. Technical and Operational Benefits of Experimentation with Resupply Position Parameters.

2.1 Stated specifications. The FARV and AFAS will be able to transload projectiles, fuel and propellant from all trafficable slopes (40% lateral, 60% longitudinal) as long as the misalignment between vehicles is 10° or less. The on-board materials handling equipment must also be able to load, move, store, secure and unload projectiles, propellant and fuel without requiring the crew to get out of the crew cab on all trafficable slopes.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. N/A.

2.3 Sample Experiment. There are several types of experiments that can be accomplished either in software, in the DIS environment or a combination of the two. A single experiment/scenario in the DIS virtual environment can address each of the specifications of performance outlined above. Analysts and testers can run the same experiment repeatedly, incrementally altering parameters or designs to determine operational and technical tradeoffs offered by alternative crew station configurations, soldier-machine interfaces (SMIs), BCC designs, and autoloading designs/times.

Installation of a virtual ammunition transfer and handling system prototype in the AFAS and FARV simulator provides the opportunity to experiment with various SMIs, software design architectures, and component capabilities to determine the best fit to meet overall response time and rate of fire requirements. If the fidelity of the ammunition transfer and autoloader is high enough, the tester could investigate the ability of the system to transfer ammunition when the AFAS and FARV are situated on terrain that have steep slopes. Emulating the ammunition transfer and handling system prototype will allow the investigation into the combined effects of different degrees of slope on the stresses on the material handling system. For example, if the automatic materials handling emulation software has an interactive, selectable degree of slope feature, the impact of variable stress on various autoloading components, designs and on overall mission capable rates and resupply time requirements may be determined. If there are adverse effects, then the emulation software can be modified so that there are no adverse effects and then be used to determine the impact of the restrictions on mission effectiveness in a DIS scenario. The overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario.

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One FARV crew to man an FARV simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One FARV simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One AFATDS POC computer to process the resupply requests during centralized AFAS operations, automatically relay resupply requests during decentralized operations, and update AFAS information base on types and quantity of ammunition, fuel and propellant.
- One AFAS SAFOR to support senior to subordinate AFAS operations
- One FARV SAFOR to support senior to subordinate AFAS operations
- Threat SAFOR operations order
- Threat SAFOR to execute the order
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

4. Emulators Required. The following models or emulations will be needed to support the AFAS and FARV simulators.

1. Primary ammunition handling and transfer mechanism for both vehicles.
2. Primary chassis and suspension emulation packages consisting of models representing springs/torsion bars, road wheels, tracks and track pads.

3. Chassis model (in software) consisting of chassis, turret, gun tube, crew cab, etc. Primary interest in the DIS testing is in the chassis-ammunition storage design and materials handling systems and their configuration and interaction the other FARV/AFAS vehicle's material handling systems.

Subject of Experimentation/Testing: AFAS Ammunition Capacity

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Storage Capacity	Live or Virtual		**Accuracy**	
Automatically store 90 complete rounds.		Number of rounds stored	Record of on-board projectile/fuze inventory by projectile and fuze combination	Signal PDU
Automatically store propellant equal to 75 percent of maximum charge for the total of all rounds carried, including Copperhead.			Record of physical count of ammunition uploaded by projectile and fuze combination	Event Report PDU
Manually store two (2) M712 Copperhead projectiles.		Number of liters of LP stored	Number of liters of LP propellant loaded	Signal PDU
			Record of quantity of LP system indicates is on-board the receiving vehicle	Event Report PDU
Store (TBD) number of rounds of secondary armament munitions		Number of rounds of secondary armament munitions stored	Record of on-board secondary armament munition inventory by type	Signal PDU
			Record of physical count of secondary armament munition inventory by type	Event Report PDU
Compatibility	Live		**Compatibility**	New entity type values need to be defined for several types of munitions not currently defined in DIS standards.
Automatically handle all current and developmental fuzed U.S. 155mm projectiles not exceeding 1 meter in length.			Record of *incidents* when ammunition was not compatibility	
Projectiles - M107, M110, M110A1, M110A2, M116A1, M121A1, M449, M449A1, M485A1, M485A2, M804, M483A1, M483A2, M687, M692, M718, M718A1, M731, M741, M741A1, M795, M825A1, M549A1, M864, XM867, XM898, XM951, XM971 and XM982.			Reason for incompatibility	
Fuzes - M739 (PD), MK399 Mod 1, M762 (ET), XM767 (ET) and XM773 (MOFA)				
Manually handle Copperhead projectiles.				

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow evaluation of the tactics, techniques and procedures and key operational capabilities available to support and determine AFAS ammunition capacity and capabilities. The AFAS as a component of the "system of systems - the Field Artillery" must be able to transfer, store, load and fire a number of projectile and fuze combinations on the battlefield to effectively and efficiently complete its mission. The system could be looked at for integration of various levels of automation, expert (decision aids) systems and controls/displays and their impact on the operational effectiveness on the battlefield. Assessment of the adequacy, maturity and compatibility of AFAS capabilities could be made. Selection and development of new or revised tactics, techniques and procedures could be pursued. Operation with the software of other FA systems and vehicles, including the FARV, demonstrates the system's ability to operate within the FA digital communications network.

2.1 Stated specifications:

- Storage Capacity
- Compatibility

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the AFAS System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains a number of fire missions with varied target descriptions and target sizes, sufficient fire missions could be generated to fire every projectile and fuze combination compatible with the AFAS system. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the AFAS specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Median Times of Reload/Rearm/Resupply Operations
- Average Rate of Reload/Rearm/Resupply Operations
- Accuracy of Reload/Rearm/Resupply Operations
- Compatibility with Ammunition by type and size
- Number of missions completed
- Number and type of Reload/Rearm/Resupply operations conducted
- Number and types of projectile/fuze combinations resupplied
- Number and types of projectile/fuze combinations fired
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to resupply operations
- Number and type of manual upload and unload operations conducted

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software
- One FARV SAFOR to support AFAS to FARV resupply/rearm/refuel, communications and docking operations
- One SAFOR PLS Truck to support LRP Operations
- One SAFOR fuel truck to support LRP refueling operations
- A Time Ordered Events List (TOEL)

Subject of Experimentation/Testing: FARV Ammunition Capacity

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Storage Capacity	Live or Virtual		**Accuracy**	
Automatically store 130-200 complete rounds.		Number of rounds stored	Record of on-board projectile/fuze inventory by projectile and fuze combination	Signal PDU
Automaticall: store propellant equal to 75 percent of maximum charge for the total of all rounds carried, including Copperhead.			Record of physical count of ammunition uploaded by projectile and fuze combination	Event Report PDU
Manually store two (2) M712 Copperhead projectiles.		Number of liters of LP stored	Number of liters of LP propellant loaded Record of quantity of LP system indicates is on-board the vehicle	Signal PDU Event Report PDU
Store (TBD) number of rounds of secondary armament munitions		Number of rounds of secondary armament munitions stored	Record of on-board secondary armament munition inventory by type Record of physical count of secondary armament munition inventory by type	Signal PDU Event Report PDU
Compatibility	Live		**Compatibility**	New entity type values need to be defined for several types of munitions not currently defined in DIS standards.
Automatically handle all current and developmental fuzed U.S. 155mm projectiles not exceeding 1 meter in length. Projectiles - M107, M110, M110A1, M110A2, M116A1, M121A1, M449, M449A1, M485A1, M485A2, M804, M483A1, M483A2, M687, M692, M718, M718A1, M731, M741, M741A1, M795, M825A1, M549A1, M864, XM867, XM898, XM951, XM971 and XM982. Fuzes - M739 (PD), MK399 Mod 1, M762 (ET), XM767 (ET) and XM773 (MOFA) Manually handle Copperhead projectiles.			Record of *incidents when ammunition was not* compatibility Reason for incompatibility	

Subject o. .erimentation/Testing: FARV Ammunition Capacity

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow evaluation of the tactics, techniques and procedures and key operational capabilities available to support and determine FARV ammunition capacity and capabilities. The FARV as a component of the "system of systems - the Field Artillery" must be able to transfer, store and load a number of projectile and fuze combinations on the battlefield to effectively and efficiently complete its mission in support of the AFAS. The system could be looked at for integration of various levels of automation, expert (decision aids) systems and controls/displays and their impact on the operational effectiveness on the battlefield. Assessment of the adequacy, maturity and compatibility of FARV ammunition capabilities could be made. Selection and development of new or revised tactics, techniques and procedures could be pursued. Operation with the software of other FA systems and vehicles, including the AFAS, demonstrates the system's ability to operate within the FA digital communications network.

2.1 Stated specifications:

- Storage Capacity
- Compatibility

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 **Sample Experiment.** A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the FARV System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains a number of fire missions with varied target descriptions and target sizes, sufficient fire missions could be generated to fire every projectile and fuze combination compatible with the FARV system. Placing the FARV simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the FARV specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Median Times of Reload/Rearm/Resupply Operations
- Average Rate of Reload/Rearm/Resupply Operations
- Accuracy of Reload/Rearm/Resupply Operations
- Compatibility with Ammunition by type and size
- Number of missions completed
- Number and type of Reload/Rearm/Resupply operations conducted
- Number and types of projectile/fuze combinations resupplied
- Number and types of projectile/fuze combinations fired
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to resupply operations
- Number and type of manual upload and unload operations conducted

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software
- One FARV SAFOR to support AFAS to FARV resupply/rearm/refuel, communications and docking operations
- One SAFOR PLS Truck to support LRP Operations
- One SAFOR fuel truck to support LRP refueling operations
- A Time Ordered Events List (TOEL)

Subject of Experimentation/Testing: AFAS Docking

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Docking Time - Favorable Terrain. The AFAS shall be capable to receive and store 60 complete rounds of primary armament munitions (except Copperhead) in less than 12 minutes (time includes docking, transfer cargo, and undock on slopes (any direction) of less than 10 degrees resultant angle between vehicles).	Live or Virtual		**Time**	
		Median Docking Time	Time Docking completed	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Resultant angle (in degrees) between vehicles	Event Report PDU
		Median Time of Resupply Operation	Time receiver system acknowledges control of resupply operation	Signal PDU
			Time of undocking	Event Report PDU
		Total Time of Resupply Operation	Time of undocking	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Accuracy	
		Accuracy of resupply data exchange	Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Receiver system)	Event Report PDU
			Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Sender system)	Event Report PDU

Subject of Experimentation/Testing: AFAS Docking

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Docking Time - Unfavorable Terrain. Once the vehicles (AFAS and FARV or FARV and another FARV) are within 8 meters of each other, and respective rearm ports are facing each other, The Rearm/Resupply Subsystem shall be able to dock and connect in [TBD] minutes under adverse conditions (slopes, any direction up to 10 degrees resultant angle between vehicles.)	Live or Virtual		**Time**	
		Median Docking Time	Time Docking completed	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Resultant angle (in degrees) between vehicles	Event Report PDU
		Median Time of Resupply Operation	Time receiver system acknowledges control of resupply operation	Signal PDU
			Time of undocking	Event Report PDU
		Total Time of Resupply Operation	Time of undocking	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Accuracy	
		Accuracy of resupply data exchange	Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Receiver system)	Event Report PDU
			Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Sender system)	Event Report PDU
Docking Under Cover. The Rearm/Resupply Subsystem shall not require personnel outside either vehicle during docking operations.	Live or Virtual		**Capability**	
			Record of resupply operations conducted with crew members outside of the vehicle during docking operations	X
			Reason for crew member being required to be outside the vehicle	X
Rapid Disconnect. The Rearm/Resupply Subsystem shall be able to perform a rapid disconnect (less than 10 seconds) with no damage to components of the FARV or AFAS and no loss of projectiles.	Live or Virtual	Median Rapid Disconnect Time	**Time**	
			Time rapid disconnect initiated	X
			Time rapid disconnect initiated	X
			Record of projectile loss	X
			Record of damaged components	X
			Reason for rapid disconnect	X
Disconnect without Spillage of Fuel. Rapid disconnect from the other vehicle shall not result in more than [TBD] liters of fuel spillage.	Live or Virtual	Average Amount of Fuel Spillage from Rapid Disconnect Operations	**Quantity**	
			Record of quantity of fuel spillage that resulted from rapid disconnect operations	X
			Reason for rapid disconnect	X

Subject of Experimentation/Testing: AFAS Docking

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is *Appropriate Environment*	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Interface. The AFAS shall have a physical interface with the FARV. The interface shall include a power interface, an ammunition transfer interface, a fuel transfer interface, and a communications interface. With the exception of the power interface, these interfaces shall be achieved via the docking of the system with the FARV.	Live or Virtual		**Capability** Record of fuel transfers completed through docking interface Record of voice and digital communications conducted through the docking interface Record of ammunition transfers conducted through the docking interface	 Signal PDU Signal PDU Signal PDU
Disconnect Without Spillage of Propellant. Rapid disconnect from the other vehicle shall not result in more than [TBD] liters of liquid propellant spillage.	Live or Virtual	Average Amount of Fuel Spillage from Rapid Disconnect Operations	**Quantity** Record of quantity of LP propellant spillage that resulted from rapid disconnect operations Reason for rapid disconnect	 X Event Report PDU
Communications Link. When the FARV and AFAS, or FARV and another FARV, are docked together a voice and data communications connection must be automatically established.	Live or Virtual		**Capability** Record of digital communications between vehicles when docked Record of voice communications between vehicles when docked	 Signal PDU Signal PDU
Fuel Transfer. The AFAS shall be capable of remotely and simultaneously transferring fuel from its own fuel cell into the FARV at a rate of at least 132 liters per minute.	Live or Virtual	Median Fuel Transfer Time Median Fuel Transfer Rate	**Time** Time fuel transfer stopped Time fuel transfer started **Rate** Quantity (in liters) of fuel transferred Total time required for fuel transfer	 Event Report PDU Event Report PDU Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Docking

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow demonstration of key technologies in docking related to automated resupply of ammunition, propellant and fuel. It would also permit evaluation of reduced rearm time, increased payload capability of 60 rounds, crew size and workload task analysis. The system could be looked at for integration of automation, expert (decision aids) systems and controls/displays. Assessment of the adequacy, maturity and compatibility of ammunition transfer operations. Evaluate potential for integration into a combat support system. Evaluate selection and development of technologies. Demonstrate the achievability of the new technologies being applied to the AFAS (automation, advanced propellant handling, ammunition management, and automated ammunition transfer and docking).

2.1 Stated specifications:

- Docking Time - Favorable Terrain
- Docking Time - Unfavorable Terrain
- Docking Under Cover
- Rapid Disconnect
- Disconnect without Spillage of Fuel
- Disconnect without Spillage of Propellant
- Physical Interface
- Communications Link
- Fuel Transfer

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment.

- Overall effectiveness of docking operations between AFAS and FARV.
- Overall effectiveness of resupply operations supporting combat operations at battlefield tempo.

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering designs to determine operational and technical tradeoffs offered by different docking configurations, soldier-machine interfaces (SMIs), and varied terrain. For example, if AFAS simulator software has a selectable docking capabilities (fuel transfer rate, propellant transfer rate, different docking mechanisms, different and selectable interfaces for fuel, propellant, communications and ammunition), the impact of various docking and interface designs on docking time and requirements may be determined. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of docking accuracy to the degree specified in the AFAS specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Median docking times
- Number of dockings completed
- Median resupply times
- Number of resupply operations conducted
- Accuracy of resupply data exchanges
- Number of rapid disconnects
- Median time required to conduct rapid disconnect operations
- Number of liters of fuel spilled during rapid disconnect operations
- Fuel usage rates for the battle
- Number of missions fired
- Number of projectiles fired by type
- Number of missions not fired due to ammunition shortages
- Number of missions not fired due to LP propellant shortages
- Number of missions not fired due to fuel shortages
- Fuel transfer rates during combat operations
- Ammunition transfer rates during combat operations

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

Subject of Experimentation/Testing: AFAS Docking

- One AFAS crew to man an AFAS simulator
- One FARV crew to man an FARV simulator
- One AFAS simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update FARV information base on LRP locations, resupply requests and operations and battlefield information.
- One AFAS and FARV SAFOR to support senior to subordinate AFAS operations
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

Subject of Experimentation/Testing: FARV Docking

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Docking Time - Favorable Terrain. The FARV shall be capable of transferring 60 complete rounds of primary armament munitions (except Copperhead) to the AFAS in less than 12 minutes (time includes docking, transfer cargo, and undock on slopes (any direction) of less than 10 degrees resultant angle between vehicles).	Live or Virtual		**Time**	
		Median Docking Time	Time Docking completed	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Resultant angle (in degrees) between vehicles	Event Report PDU
		Median Time of Resupply Operation	Time receiver system acknowledges control of resupply operation	Signal PDU
			Time of undocking	Event Report PDU
		Total Time of Resupply Operation	Time of undocking	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Accuracy	
		Accuracy of resupply data exchange	Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Receiver system)	Event Report PDU
			Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Sender system)	Event Report PDU

Subject of Experimentation/Testing: FARV Docking

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Docking Time - Unfavorable Terrain. Once the vehicles (AFAS and FARV or FARV and another FARV) are within 8 meters of each other, and respective rearm ports are facing each other, The Rearm/Resupply Subsystem shall be able to dock and connect in [TBD] minutes under adverse conditions (slopes, any direction up to 10 degrees resultant angle between vehicles.)	Live or Virtual		**Time**	
		Median Docking Time	Time Docking completed	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Resultant angle (in degrees) between vehicles	Event Report PDU
		Median Time of Resupply Operation	Time receiver system acknowledges control of resupply operation	Signal PDU
			Time of undocking	Event Report PDU
		Total Time of Resupply Operation	Time of undocking	Event Report PDU
			Time Docking initiated (when AFAS and FARV are within 8 m (26.25 ft) and respective resupply ports are facing each other)	Event Report PDU
			Accuracy	
		Accuracy of resupply data exchange	Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Receiver system)	Event Report PDU
			Number of complete rounds resupplied by lot, projectile with fuze, quantity and weight (Sender system)	Event Report PDU
Docking Under Cover. The Rearm/Resupply Subsystem shall not require personnel outside either vehicle during docking operations.	Live or Virtual		**Capability**	
			Record of resupply operations conducted with crew members outside of the vehicle during docking operations	X
			Reason for crew member being required to be outside the vehicle	X
Rapid Disconnect. The Rearm/Resupply Subsystem shall be able to perform a rapid disconnect (less than 10 seconds) with no damage to components of the FARV or AFAS and no loss of projectiles.	Live or Virtual	Median Rapid Disconnect Time	**Time**	
			Time rapid disconnect initiated	X
			Time rapid disconnect initiated	X
			Record of projectile loss	X
			Record of damaged components	X
			Reason for rapid disconnect	X
Disconnect without Spillage of Fuel. Rapid disconnect from the other vehicle shall not result in more than [TBD] liters of fuel spillage.	Live or Virtual	Average Amount of Fuel Spillage from Rapid Disconnect Operations	**Quantity**	
			Record of quantity of fuel spillage that resulted from rapid disconnect operations	X
			Reason for rapid disconnect	X

Subject of Experimentation/Testing: FARV Docking

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Disconnect Without Spillage of Propellant. Rapid disconnect from the other vehicle shall not result in more than [TBD] liters of liquid propellant spillage.	Live or Virtual	Average Amount of Fuel Spillage from Rapid Disconnect Operations	**Quantity** Record of quantity of LP propellant spillage that resulted from rapid disconnect operations Reason for rapid disconnect	 X Event Report PDU
Physical Interface. The FARV shall have a physical interface with AFASs and other FARVs. The interface shall include a power interface, an ammunition transfer interface, a fuel transfer interface, and a communications interface. With the exception of the power interface, these interfaces shall be achieved via the docking of the system with the AFAS or FARV.	Live or Virtual		**Capability** Record of fuel transfers completed through docking interface Record of voice and digital communications conducted through the docking interface Record of ammunition transfers conducted through the docking interface	 Signal PDU Signal PDU Signal PDU
Communications Link. When the FARV and AFAS, or FARV and another FARV, are docked together a voice and data communications connection must be automatically established.	Live or Virtual		**Capability** Record of digital communications between vehicles when docked Record of voice communications between vehicles when docked	 Signal PDU Signal PDU
Fuel Transfer. The AFAS shall be capable of remotely and simultaneously transferring fuel from its own fuel cell into the FARV at a rate of at least 132 liters per minute.	Live or Virtual	 Median Fuel Transfer Time Median Fuel Transfer Rate	**Time** Time fuel transfer stopped Time fuel transfer started **Rate** Quantity (in liters) of fuel transferred Total time required for fuel transfer	 Event Report PDU Event Report PDU Event Report PDU Event Report PDU

Subject of Experimentation/Testing: FARV Docking

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow demonstration of key technologies in docking related to automated resupply of ammunition, propellant and fuel. It would also permit evaluation of reduced rearm time, increased payload capability of between 130 and 200 rounds, crew size and workload task analysis. The system could be looked at for integration of automation, expert (decision aids) systems and controls/displays. Assessment of the adequacy, maturity and compatibility of ammunition transfer operations. Evaluate potential for integration into a combat support system. Evaluate selection and development of technologies. Demonstrate the achievability of the new technologies being applied to the AFAS (automation, advanced propellant handling, ammunition management, and automated ammunition transfer and docking).

2.1 Stated specifications:

- Docking Time - Favorable Terrain
- Docking Time - Unfavorable Terrain
- Docking Under Cover
- Rapid Disconnect
- Disconnect without Spillage of Fuel
- Disconnect without Spillage of Propellant
- Physical Interface
- Communications Link
- Fuel Transfer

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment.

- Overall effectiveness of docking operations between AFAS and FARV.
- Overall effectiveness of resupply operations supporting combat operations at battlefield tempo.

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering designs to determine operational and technical tradeoffs offered by different docking configurations, soldier-machine interfaces (SMIs), and varied terrain. For example, if FARV simulator software has a selectable docking capabilities (fuel transfer rate, propellant transfer rate, different docking mechanisms, different and selectable interfaces for fuel, propellant, communications and ammunition), the impact of various docking and interface designs on docking time and requirements may be determined. Placing the FARV simulator on a combined arms virtual battlefield may not permit validations of docking accuracy to the degree specified in the FARV specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Median docking times
- Number of dockings completed
- Median resupply times
- Number of resupply operations conducted
- Accuracy of resupply data exchanges
- Number of rapid disconnects
- Median time required to conduct rapid disconnect operations
- Number of liters of fuel spilled during rapid disconnect operations
- Fuel usage rates for the battle
- Number of missions fired
- Number of projectiles fired by type
- Number of missions not fired due to ammunition shortages
- Number of missions not fired due to LP propellant shortages
- Number of missions not fired due to fuel shortages
- Fuel transfer rates during combat operations
- Ammunition transfer rates during combat operations

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

Subject of Experimentation/Testing: FARV Docking

- One AFAS crew to man an AFAS simulator
- One FARV crew to man an FARV simulator
- One AFAS simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update FARV information base on LRP locations, resupply requests and operations and battlefield information.
- One AFAS and FARV SAFOR to support senior to subordinate AFAS operations
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Upload Rate (PLS to AFAS). When the FARV is unavailable, the AFAS shall be capable of supporting a crew performed manual upload of fuzed projectiles and propellant from combat configured loads on PLS flatracks at an average rate of one complete round per minute. The upload (rearm) function includes required processing of fuzes and projectiles plus data entry including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Live or Virtual	Median Time of Upload	**Time** Time upload finished Time upload started Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
		Average Upload Rate	**Rate** *Total time required to conduct upload* Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members	
		Accuracy of Upload	**Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	
Download (AFAS to FARV). The AFAS shall be capable of automatically downloading 60 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 20 minutes. The AFAS crew must be able to manually transfer 2 Copperhead to the FARV within the time standard established for automated download. The AFAS must allow the crew to manually unload 60 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 45 minutes.	Live or Virtual	Median Download Time	**Time** Time when the FARV is again capable of maneuver (Stop Time) Time when the system initiates a maneuver to conduct docking (Start Time) Number of rounds loaded Number of liters LP propellant loaded Time stopped transfer of 2 Copperheads Time started transfer of 2 Copperheads	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
		Average Download Rate	**Rate** Total time required to conduct download/unload Number of rounds downloaded/unloaded Number of liters LP propellant downloaded/unloaded Type of download (Automated or Manual)	
		Accuracy of Download	**Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Exchange (AFAS to FARV). The AFAS shall be capable of receiving ammunition from the FARV at a rate of not less than 3 complete processed rounds of primary armament munitions (except Copperhead) per minute. The exchange of 60 complete processed rounds of primary armament shall take no longer than 20 minutes.	Live or Virtual	Median Exchange Time Average Exchange Rate Accuracy of Unload	**Time** Time last round crosses the resupply port (Stop Time) Time the first round is passed through the resupply port (Stop Time) Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct unload Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
Upload Rate (FARV to AFAS). The Primary Armament Subsystem shall be able to receive and store 60 complete rounds of primary armament munitions (except Copperhead) in less than 12 minutes (time includes docking, transfer cargo, and undock on slopes (any direction) of less than 10 degrees resultant angle between vehicles). The FARV crew must be able to manually transfer 2 Copperhead to the AFAS within the time standard established for automated resupply.	Live or Virtual	Median Resupply Time Average Resupply Rate Accuracy of Download	**Time** Time when the FARV is again capable of maneuver (Stop Time) Time when the system initiates a maneuver to conduct docking (Start Time) Number of rounds resupplied Number of liters LP propellant loaded Time stopped transfer of 2 Copperheads Time started transfer of 2 Copperheads **Rate** Total time required to conduct resupply Number of rounds resupplied Number of liters LP propellant resupplied Type of resupply (Automated or Manual) **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Compatibility (Ammunition). The AFAS must be capable of automatically handling all current and developmental (those fielded or in EMD before the start of AFAS EMD) fuzed U.S. 155mm projectiles not exceeding 1 meter in length. Projectiles - M107, M110, M110A1, M110A2, M116A1, M121A1, M449, M449A1, M485A1, M485A2, M804, M483A1, M483A2, M687, M692, M718, M718A1, M731, M741, M741A1, M795, M825A1, M549A1, M864, XM867, XM898, XM951, XM971 and XM982. Fuzes - M739 (PD), MK399 Mod 1, M762 (ET), XM767 (ET) and XM773 (MOFA) M712 Copperhead may be loaded and transferred to AFAS manually.	Live		**Compatibility** Record of incidents when ammunition was not compatibility Reason for incompatibility	New entity type values need to be defined for several types of munitions not currently defined in DIS standards.
Compatibility (Ammunition Systems). The AFAS must be capable of operating with current and developmental munitions packaging systems and automated loading systems (those fielded or in EMD and before the start of AFAS EMD).	Live or Virtual		**Compatibility** Type of automated loading system used (AIRRS, FAAPS, etc.) Type of munitions packaging system used (PLS Flatrack, pallets, etc.) Type of loading operation conducted (Automated, Semi-Automated or Manual)	Not Applicable
Decision Aid Capability. The AFAS must have an embedded decision aid capability to assist the crew in making tactical decisions associated with conducting and management and conduct of support operations.	Live or Virtual		**Capability** Number of resupply and support operations conducted with Decision Aids Number of resupply and support operations conducted without Decision Aids Crew comments on operations conducted with and without Decision Aids	 Event Report PDU Event Report PDU X
Interoperability. The AFAS system shall be compatible with and integrate C3I actions with the Advanced Field Artillery Tactical Data System (AFATDS). The AFAS system, at least through the Dem/Val phase, shall be fully compatible and interactive with TACFIRE Version 10, FSS-IS-1171. The AFAS must interface with the C3I architecture of FARV.	Live or Virtual	 Percent of incoming messages translated without error Percent of outgoing messages translated without error	**Completeness** Number of messages received by the AFAS Number of messages properly acknowledged (ACK) Number of messages not acknowledged (NAK) Number of messages sent by the system Number of messages properly acknowledged (ACK) by the receiver Number of messages not acknowledged (NAK) by the receiver	 Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. The AFAS must provide intervehicular voice communications and digital transfer of data with the FARV when connected for resupply/download operations. The POC or senior howitzer if in a subordinate role shall be automatically informed of the current on-board ammunition inventory after each mission, after completion of ammunition resupply, and after ammunition download.	Live or Virtual	Percent of correct digital transfers of data during resupply operations	**Completeness** Number of automated resupply operations attempted Number of automated resupply operations completed Records of digital transfer of data Record of intervehicular voice communications during resupply operations	 Event Report PDU Event Report PDU Signal PDU Signal PDU
The AFAS shall automatically transmit a message to the POC whenever there is a change in system status that affects mission capability, including changes in on-board supplies inventories.		Percent of inventory status reports sent	**Accuracy** Number of on-board ammunition status changes Type of operation (rearm, upload, download, transload, correction, etc.) Number of on-board ammunition inventory messages sent	 Signal PDU Signal PDU Signal PDU
When the AFAS is docked with a FARV, voice/data communications shall be established and automatically initiated as a part of the mating of two vehicles in preparation for resupply. This link shall provide for the transfer of all control data required to coordinate the transfer processes.		Percent of successful automated docking links	**Compatibility** Number of dockings Number of data exchanges conducted to initiate and control interchange of data between systems	 Event Report PDU Signal PDU
When uploading ammunition and fuel from the FARV, the AFAS shall send/receive data to/from the FARV over the communications link during docking.		Percent of successful data exchanges	**Capability** Number of data exchanges initiated between systems Number of data exchanges conducted between systems	 Signal PDU Signal PDU
The on-board ammunition inventory shall be automatically updated after each round is fired, after receipt of ammunition (upload, download, rearm, or other supply transaction) which requires changes to on-board inventory information.		Percent of successful ammunition updates	**Accuracy** Number of ammunition inventory updates Number of instances where inventory required update Reason for update (rearm, upload, download, transload, correction, etc.)	 Event Report PDU Event Report PDU Event Report PDU
When conducting resupply operations (Manual and with FARV), the AFAS shall transmit (when downloading) or receive (When uploading) the following information, as applicable: LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.		Accuracy of resupply data exchange	**Accuracy** Number of fuzed projectiles by lot, fuze, type and weight transferred by sending system Number of fuzed projectiles by lot, fuze, type and weight accepted by receiving system Number of LP liters transferred by sending system Number of LP liters accepted by receiving system Type of operation (rearm, upload, download, transload, correction, etc.)	 Signal PDU Event Report PDU Signal PDU Event Report PDU Signal PDU

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Data Entry.	Live or Virtual		**Accuracy**	
During resupply of previously coded projectiles, the AFAS shall verify the projectile coding (projectile's type, lot, fuze and fuzed weight) matches the data specified on the inventory received during resupply.		Percent of correct projectile coding events	Number of attempts to read projectile data	Event Report PDU
			Number of projectiles and data accepted by the system	Event Report PDU
			Accuracy	
		Accuracy of reading projectile data	Record of data read by the projectile coding system by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Event Report PDU
			Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Event Report PDU
			Accuracy	
The AFAS crew must be able to manually enter data into the AFAS system including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.		Accuracy of manual entry of projectile data	Record of data entered by operator by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Event Report PDU
			Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Event Report PDU
			Record of observed operator input errors	Event Report PDU
Selectability.	Live or Virtual		**Accuracy**	
Fuzed projectiles and liquid propellant stored within the AFAS shall be automatically accessible by the system.		Percent of requests satisfied	Record of data requested by receiving system	Signal PDU
			Record of data provided by sending system	Signal PDU
The AFAS must provide for automated ammunition selection, transfer, cataloging and inventory of fuzed projectiles, fuel and propellant.			Record of automated ammunition selection requests by quantity of propellant, type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Signal PDU
			Record of requested quantities furnished by quantity of propellant, type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Signal PDU

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Storage. The AFAS shall store, within the integral structure of the vehicle, at least 60 complete processed rounds of primary armament munitions. The Copperhead propellant will be stored with the propellant from the other 130 complete processed rounds. Stowed primary armament ammunition shall be accessible by the crew without having to exit the vehicle.	Live or Virtual		**Capability** Number of complete processed rounds stored Number of Copperhead rounds stored Storage location for Copperhead propellant and rounds Quantity of LP and Copperhead propellant stored Record of data system inventory by quantity of propellant, type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	 Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU
Control. During transfer of munitions or fuel, the C3 Subsystem shall permit the system receiving ammunition, LP and fuel to control the resupply process (request ammunition orders, issue stop/go/disconnect commands, etc.). This process can be interrupted in an emergency.	Live or Virtual	Percent of error of resupply commands	**Accuracy** Number of instances where receiver (controller) issued commands Number of instances where sender (controller) properly actioned the requested command Type of instruction issued (request ammunition orders, issue stop/go/disconnect commands, etc.) Number of emergency interruptions Reason for emergency interruption	 Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU
Docking under cover. The AFAS shall be able to dock with a FARV without requiring the crew to leave the crew compartment.	Live or Virtual		**Capability** Record of dockings with crew out of compartment Record of dockings with crew in compartment	 Event Report PDU Event Report PDU
Power. The AFAS must be able to accept sufficient power from an external source to enable the AFAS to download ammunition, run diagnostic routine or start the engine.	Live or Virtual		**Capability** Record of instances where external power was required Record of instances were external power was applied and successful	 Event Report PDU Event Report PDU
Rapid Disconnect. The AFAS shall be able to undock from a FARV within 10 seconds with no damage to components, no loss of projectiles, and minimal spillage of fuel and liquid propellant.	Live or Virtual	 Median rapid disconnect time	**Time** Time rapid disconnect action completed Time rapid disconnect action initiated Record of damage to components Record of lost projectiles Record of LP spillage Record of fuel spillage	 Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** A DIS Virtual Environment would allow demonstration of key technologies in automated resupply of ammunition, propellant and fuel. It would also permit evaluation of reduced rearm time, payload capability (60 rounds), crew size and workload task analysis. The system could be looked at for levels and integration of automation, expert (decision aids) systems and controls/displays. The assessment of the adequacy, maturity and compatibility of ammunition transfer operations could be made based on results of the experiments. Several iterations of simulated battle covering 48 to 96 hours each of combat would provide sufficient data to evaluate the AFAS and its impact on the combat support system in terms of resupply priorities, requisitions, configurations of CCL loads, types and quantities of ammunition requested, fired and returned. A DIS experimental approach would permit evaluation and development of selected technologies. DIS experiments could demonstrate the suitability of the new technologies being applied to the AFAS covering automation, advanced propellant handling, ammunition management, and automated ammunition transfer and docking.

2.1 Stated specifications:

- Upload Rate (PLS to AFAS)
- Download Rate (AFAS to FARV)
- Exchange Rate (AFAS to FARV)
- Upload Rate (FARV to AFAS)
- Compatibility (Ammunition)
- Compatibility (Ammunition Systems)
- Decision Aid Capability
- Interoperability
- Communications
- Data Entry
- Selectability
- Storage
- Control
- Docking Under Cover
- Power
- Rapid Disconnect

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment.

- Overall effectiveness of ammunition transfer operations between AFAS, FARV and the LRP.
- Effectiveness, timeliness, appropriateness and communications net loading of communications between systems.

2.3 **Sample Experiment.** A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the AFAS System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains threat air and ground forces, AFAS engagement of these systems could occur. Crew reactions, crew tasks, timeline analysis, weapon engagements and results could be gathered and the results assessed by different ammunition transfer technologies and their impact on the battle. This sequence of events could evaluate the overall impact on system and crew's capability to meet battlefield and system rearm and resupply requirements. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the AFAS specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Median Times of Upload, Download, Unload, Exchange and Transload Operations
- Average Rate of Upload, Download, Unload, Exchange and Transload Operations
- Accuracy of Upload, Download, Unload, Exchange and Transload Operations
- Compatibility with Ammunition combinations by type
- Compatibility with Ammunition systems
- Number and type of reload operations conducted
- Number and types of projectile/fuze combinations resupplied
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to resupply operations
- Number and type of manual reload operations conducted
- Number of rapid disconnect operation conducted
- Number of reload operations conducted from an external power source

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

Subject of Experimentation/Testing: AFAS Ammunition Transfer Operations

- One AFAS crew to man an AFAS simulator
- One FARV crew to man an FARV simulator
- One AFAS simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update FARV information base on LRP locations, resupply requests and operations and battlefield information.
- One AFAS and FARV SAFOR to support senior to subordinate AFAS operations
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Upload Rate (Supply Point to FARV). Upload 130 complete rounds in less than 65 minutes from a Combat Configured Load (CCL) on a PLS truck or grounded flatrack. At this resupply point as part of the upload process, the FARV personnel shall prepare the ammunition for storage aboard the FARV.	Live or Virtual	Median Time of Upload	**Time** *Time upload finished* Time upload started Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, *Resupply Cancel PDU and Event Report PDU can* accommodate the data elements for this function.
		Average Upload Rate	**Rate** Total time required to conduct upload Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members	
		Accuracy of Upload	**Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	
Download (AFAS to FARV). *Once the AFAS and FARV are within 8* meters of each other and supply ports are facing each other, the FARV must be able to automatically maneuver, dock, transfer 60 complete rounds (excluding Copperhead) and undock with AFAS, on slopes (in any direction) of up to 10 degrees between vehicles (resultant angle) in any operational condition in less than 12 minutes. The AFAS crew must be able to manually transfer 2 Copperhead to the FARV within the time standard established for automated download. When required for maintenance or other operational reasons, fuzed projectiles and liquid propellant shall be capable of being manually downloaded at a rate of at least 130 complete rounds in less than 90 minutes with the system in an unpowered state.	Live or Virtual	Median Download Time	**Time** *Time when the FARV is again capable of* maneuver (Stop Time) Time when the system initiates a maneuver to conduct docking (Start Time) Number of rounds loaded Number of liters LP propellant loaded Time stopped transfer of 2 Copperheads Time started transfer of 2 Copperheads	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, *Resupply Cancel PDU and Event Report PDU can* accommodate the data elements for this function.
		Average Download Rate	**Rate** Total time required to conduct download Number of rounds downloaded Number of liters LP propellant downloaded Type of download (Automated or Manual)	
		Accuracy of Download	**Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot *System round count by projectile fuze* combination, and fuze and projectile lot	

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Download (FARV to FARV). The FARV must be capable of completely and automatically downloading 130 complete rounds (excluding Copperhead) to another FARV within 20 minutes after docking. The FARV crew must be able to manually transfer 2 Copperhead to another FARV within the time standard established for automated download.	Live or Virtual	 Median download time Average Download Rate Accuracy of Download	**Time** Time last item (projectile, LP or fuel) passed through the rearm port. (Stop Time) Time docking (FARV to FARV) was verified (Start Time) Time stopped transfer of 2 Copperheads Time started transfer of 2 Copperheads Number of rounds downloaded Number of liters LP propellant downloaded **Rate** Total time required to conduct download Number of rounds downloaded Number of liters LP propellant downloaded Type of download (Automated or Manual) **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
Unload (FARV to Ground). The FARV must have the capability to automatically unload 130 complete rounds (fuzed projectiles and LP propellant to containers) to a CCL flatrack or to the ground in less than 30 minutes. The FARV crew must be able to manually unload 130 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 90 minutes	Live or Virtual	 Median Unload Time Average Unload Rate Accuracy of Unload	**Time** Time unload finished Time unload started Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct unload Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Exchange (AFAS to FARV). The FARV shall be capable of receiving ammunition from the AFAS at a rate of not less than 3 complete processed rounds of primary armament munitions (except Copperhead) per minute. The exchange of 60 complete processed rounds of primary armament shall take no longer than 20 minutes.	Live or Virtual	Median Exchange Time Average Exchange Rate Accuracy of Unload	**Time** Time last round crosses the resupply port (Stop Time) Time the first round is passed through the resupply port (Stop Time) Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct unload Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
Transload (FARV to FARV). A FARV shall be capable of automatically transferring 130 complete processed rounds of primary armament munitions (except Copperhead) to another FARV within 20 minutes after docking.	Live or Virtual	Median Transload Time Average Transload Rate Accuracy of Transload	**Time** Time both FARVs undocked (Stop Time) Time docking was confirmed (Start Time) Number of rounds transloaded Number of liters LP propellant transloaded Type of transload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct transload Number of rounds transloaded Number of liters LP propellant transloaded Type of transload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Rearm (FARV to AFAS). Once the AFAS and FARV are within 8 meters of each other and supply ports are facing each other, the FARV must be able to automatically maneuver, dock, transfer 60 complete rounds (excluding Copperhead) and undock with AFAS, on slopes (in any direction) of up to 10 degrees between vehicles (resultant angle) in any operational condition in less than 12 minutes. The FARV crew must be able to manually transfer 2 Copperhead to the AFAS within the time standard established for automated resupply.	Live or Virtual	Median Resupply Time Average Resupply Rate Accuracy of Download	**Time** Time when the FARV is again capable of maneuver (Stop Time) Time when the system initiates a maneuver to conduct docking (Start Time) Number of rounds resupplied Number of liters LP propellant loaded Time stopped transfer of 2 Copperheads Time started transfer of 2 Copperheads **Rate** Total time required to conduct resupply Number of rounds resupplied Number of liters LP propellant resupplied Type of resupply (Automated or Manual) **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
Compatibility (Ammunition). The FARV must be capable of automatically handling all current and developmental (those fielded or in EMD before the start of FARV EMD) fuzed U.S. 155mm projectiles not exceeding 1 meter in length. Projectiles - M107, M110, M110A1, M110A2, M116A1, M121A1, M449, M449A1, M485A1, M485A2, M804, M483A1, M483A2, M687, M692, M718, M718A1, M731, M741, M741A1, M795, M825A1, M549A1, M864, XM867, XM898, XM951, XM971 and XM982. Fuzes - M739 (PD), MK399 Mod 1, M762 (ET), XM767 (ET) and XM773 (MOFA) M712 Copperhead may be loaded and transferred to AFAS manually.	Live		**Compatibility** Record of incidents when ammunition was not compatibility Reason for incompatibility	New entity type values need to be defined for several types of munitions not currently defined in DIS standards.
Compatibility (Ammunition Systems). The FARV must be capable of operating with current and developmental munitions packaging systems and automated loading systems (those fielded or in EMD and before the start of FARV EMD).	Live or Virtual		**Compatibility** Type of automated loading system used (AIRRS, FAAPS, etc.) Type of munitions packaging system used (PLS Flatrack, pallets, etc.) Type of loading operation conducted (Automated, Semi-Automated or Manual)	Not Applicable

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Decision Aid Capability. The FARV must have an embedded decision aid capability to assist the crew in making tactical decisions associated with conducting and managing resupply and support operations.	Live or Virtual		**Capability**	
			Number of resupply and support operations conducted with Decision Aids	Event Report PDU
			Number of resupply and support operations conducted without Decision Aids	Event Report PDU
			Crew comments on operations conducted with and without Decision Aids	X
Interoperability. The FARV system shall be compatible with and integrate C3I actions with the Advanced Field Artillery Tactical Data System (AFATDS).	Live or Virtual		**Completeness**	
		Percent of incoming messages translated without error	Number of messages received by the FARV	Signal PDU
			Number of messages properly acknowledged (ACK)	Signal PDU
The FARV system, at least through the Dem/Val phase, shall be fully compatible and interactive with TACFIRE Version 10, FSS-IS-1171.			Number of messages not acknowledged (NAK)	Signal PDU
		Percent of outgoing messages translated without error	Number of messages sent by the system	Signal PDU
The FARV must interface with the C3I architecture of AFAS.			Number of messages properly acknowledged (ACK) by the receiver	Signal PDU
			Number of messages not acknowledged (NAK) by the receiver	Signal PDU

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. The FARV must provide intervehicular voice communications and digital transfer of data between the FARV and AFAS, or another FARV when connected for resupply/download operations.	Live or Virtual	Percent of correct digital transfers of data during resupply operations	**Completeness** Number of automated resupply operations attempted Number of automated resupply operations completed Records of digital transfer of data Record of intervehicular voice communications during resupply operations	 Event Report PDU Event Report PDU Signal PDU Signal PDU
The POC shall be automatically informed of the current on-board ammunition inventory after each rearm mission and after upload at the LRP.		Percent of inventory status reports sent	**Accuracy** Number of on-board ammunition status changes Type of operation (rearm, upload, download, transload, correction, etc.) Number of on-board ammunition inventory messages sent	 Signal PDU Signal PDU Signal PDU
When the FARV is docked with an AFAS or another FARV, voice/data communications shall be established and automatically initiated as a part of the mating of two vehicles in preparation for resupply. This link shall provide for the transfer of all control data required to coordinate the transfer processes.		Percent of successful automated docking links	**Compatibility** Number of dockings Number of data exchanges conducted to initiate and control interchange of data between systems	 Event Report PDU Signal PDU
When uploading ammunition and fuel to the AFAS or another FARV, the Communications Subsystem shall send/receive data to/from the AFAS or another FARV over the communications link per instructions of the Mission Management and Control Subsystem.		Percent of successful data exchanges	**Capability** Number of data exchanges initiated between systems Number of data exchanges conducted between systems	 Signal PDU Signal PDU
The on-board ammunition inventory shall be automatically updated after each upload, download, rearm, or other supply transaction which requires changes to on-board inventory information.		Percent of successful ammunition updates	**Accuracy** Number of ammunition inventory updates Number of instances where inventory required update Reason for update (rearm, upload, download, transload, correction, etc.)	 Event Report PDU Event Report PDU Event Report PDU
When conducting resupply operations (Manual and with FARV or AFAS), the C3 Subsystem shall transmit (when downloading) or receive (When uploading) the following information, as applicable: LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.		Accuracy of resupply data exchange	**Accuracy** Number of fuzed projectiles by lot, fuze, type and weight transferred by sending system Number of fuzed projectiles by lot, fuze, type and weight accepted by receiving system Number of LP liters transferred by sending system Number of LP liters accepted by receiving system Type of operation (rearm, upload, download, transload, correction, etc.)	 Signal PDU Event Report PDU Signal PDU Event Report PDU Signal PDU

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Data Entry. The FARV must be able to automatically read data from a projectile coding system that covers type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Live or Virtual	Percent of correct projectile coding events	Accuracy Number of attempts to read projectile data Number of projectiles and data accepted by the system	Event Report PDU Event Report PDU
		Accuracy of reading projectile data	Accuracy Record of data read by the projectile coding system by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Event Report PDU Event Report PDU
The FARV crew must be able to manually enter data into the FARV system including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.		Accuracy of manual entry of projectile data	Accuracy Record of data entered by operator by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight. Record of observed operator input errors	Event Report PDU Event Report PDU Event Report PDU
Selectability. The Resupply Subsystem shall be capable of selectively resupplying specific fuze/projectile combinations as requested by the receiving system. The FARV must provide for automated ammunition selection, transfer, cataloging and inventory of fuzed projectiles, fuel and propellant.	Live or Virtual	Percent of requests satisfied	Accuracy Record of data requested by receiving system Record of data provided by sending system Record of automated ammunition selection requests by quantity of propellant, type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight Record of requested quantities furnished by quantity of propellant, type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Storage. The Resupply Subsystem shall store, within the integral structure of the vehicle, at least 130 complete processed rounds of primary armament munitions. The Copperhead propellant will be stored with the propellant from the other 130 complete processed rounds. Stowed primary armament ammunition shall be accessible by the crew without having to exit the vehicle.	Live or Virtual		**Capability** Number of complete processed rounds stored Number of Copperhead rounds stored Storage location for Copperhead propellant and rounds Quantity of LP and Copperhead propellant stored Record of data system inventory by quantity of propellant, type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	 Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU
Rapid Disconnect. The AFAS shall be able to undock from a FARV within 10 seconds with no damage to components, no loss of projectiles, and minimal spillage of fuel and liquid propellant.	Live or Virtual	M[illegible] rapid disconnect time	**Time** Time rapid disconnect action completed Time rapid disconnect action initiated Record of damage to components Record of lost projectiles Record of LP spillage Record of fuel spillage	 Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU
Power. The AFAS must be able to accept sufficient power from an external source to enable the AFAS to download ammunition, run diagnostic routine or start the engine.	Live or Virtual		**Capability** Record of instances where external power was required Record of instances were external power was applied and successful	 Event Report PDU Event Report PDU
Docking under cover. The AFAS shall be able to dock with a FARV without requiring the crew to leave the crew compartment.	Live or Virtual		**Capability** Record of dockings with crew out of compartment Record of dockings with crew in compartment	 Event Report PDU Event Report PDU
Control. During transfer of munitions or fuel, the C3 Subsystem shall permit the system receiving ammunition, LP and fuel to control the resupply process (request ammunition orders, issue stop/go/disconnect commands, etc.). This process can be interrupted in an emergency.	Live or Virtual	Percent of error of resupply commands	**Accuracy** Number of instances where receiver (controller) issued commands Number of instances where sender (controller) properly actioned the requested command Type of instruction issued (request ammunition orders, issue stop/go/disconnect commands, etc.) Number of emergency interruptions Reason for emergency interruption	 Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** A DIS Virtual Environment would allow demonstration of key technologies in automated resupply of ammunition, propellant and fuel. It would also permit evaluation of reduced rearm time, payload capability (130 to 200 rounds), crew size and workload task analysis. The system could be looked at for levels and integration of automation, expert (decision aids) systems and controls/displays. The assessment of the adequacy, maturity and compatibility of ammunition transfer operations could be made based on results of the experiments. Several iterations of simulated battle covering 48 to 96 hours each of combat would provide sufficient data to evaluate the FARV and its impact on the combat support system in terms of resupply priorities, requisitions, configurations of CCL loads, types and quantities of ammunition requested, fired and returned. A DIS experimental approach would permit evaluation and development of selected technologies. DIS experiments could demonstrate the suitability of the new technologies being applied to the FARV covering automation, advanced propellant handling, ammunition management, and automated ammunition transfer and docking.

2.1 Stated specifications:

- Upload Rate (PLS to AFAS)
- Download Rate (AFAS to FARV)
- Exchange Rate (AFAS to FARV)
- Upload Rate (FARV to AFAS)
- Compatibility (Ammunition)
- Compatibility (Ammunition Systems)
- Decision Aid Capability
- Interoperability
- Communications
- Data Entry
- Selectability
- Storage
- Control
- Docking Under Cover
- Power
- Rapid Disconnect

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment.

- Overall effectiveness of ammunition transfer operations between AFAS, FARV and the LRP.
- Effectiveness, timeliness, appropriateness and communications net loading of communications between systems.

2.3 **Sample Experiment.** A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the FARV System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains threat air and ground forces, FARV engagement of these systems could occur. Crew reactions, crew tasks, timeline analysis, weapon engagements and results could be gathered and the results assessed by different ammunition transfer technologies and their impact on the battle. This sequence of events could evaluate the overall impact on system and crew's capability to meet battlefield and system rearm and resupply requirements. Placing the FARV simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the FARV specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Median Times of Upload, Download, Unload, Exchange and Transload Operations
- Average Rate of Upload, Download, Unload, Exchange and Transload Operations
- Accuracy of Upload, Download, Unload, Exchange and Transload Operations
- Compatibility with Ammunition combinations by type
- Compatibility with Ammunition systems
- Number and type of reload operations conducted
- Number and types of projectile/fuze combinations resupplied
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to resupply operations
- Number and type of manual reload operations conducted
- Number of rapid disconnect operation conducted

Number of reload operations conducted from an external power source

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

Subject of Experimentation/Testing: FARV Ammunition Transfer Operations

- One AFAS crew to man an AFAS simulator
- One FARV crew to man an FARV simulator
- One AFAS simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update FARV information base on LRP locations, resupply requests and operations and battlefield information.
- One AFAS and FARV SAFOR to support senior to subordinate AFAS operations
- *Friendly force operations order with fire support coordination measures and battlefield geometry*
- Friendly SAFOR to execute the order

Subject of Experimentation/Testing: AFAS LRP Operations

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual/Assisted Tasks. The AFAS shall automate as practicable (to meet upload time requirements) the processing of munitions to include actions delineated below: 1. Open fuze crates 2. Record fuze lot 3. Inspect fuze 4. Break projectile pallets 5. Remove projectile rotating band grommets and lifting plug 6. Remove projectile rocket motor or basebleed nozzle caps 7. Replace projectile nozzle caps with vapor barriers 8. Record projectile lot 9. Inspect projectile 10. Insert fuze 11. Weigh projectile/fuze combination 12. Mark projectile (type, fuze, weight, projectile lot, fuze ,lot) 13. Record all shell/fuze data in the onboard computerized inventory management system 14. Placed fuzed projectile onto loading mechanism	Live	Median Manual Task Upload Time	**Time**	
			Time upload stopped	X
			Time upload started	X
			Record of manual tasks	X
			Quantity	
		Average Number of Rounds Loaded	Number of rounds remaining on PLS flatrack	X
			Number of rounds on PLS flatrack at start	X
			Record of system inventory by projectile and fuze, lot, type, quantity and fuzed projectile weight.	X
			Type of upload (manual or semiautomated)	X
			Rate	
		Average Loading Rate (Manual)	Number of projectiles loaded	X
			Time required to load projectiles	X
			Time	
			Time upload stopped	X
		Median Semiautomated Task Upload Time	Time upload started	X
			Record of manual tasks performed	X
			Record of automated tasks performed	X
			Quantity	
			Number of rounds remaining on PLS flatrack	X
		Average Number of Rounds Loaded	Number of rounds on PLS flatrack at start	X
			Record of system inventory by projectile and fuze, lot, type, quantity and fuzed projectile weight.	X
			Type of upload (manual or semiautomated)	X
			Rate	
		Average Loading Rate (Semiautomated)	Number of projectiles loaded	X
			Time required to load projectiles	X

Subject of Experimentation/Testing: AFAS LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Upload Rate (PLS to AFAS). When the FARV is unavailable, the AFAS shall be capable of supporting a crew performed manual upload of fuzed projectiles and propellant from combat configured loads on PLS flatracks at an average rate of one complete round per minute. The upload (rearm) function includes required processing of fuzes and projectiles plus data entry including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Live or Virtual	 Median Time of Upload Average Upload Rate Accuracy of Upload	**Time** Time upload finished Time upload started Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct upload Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
Unload (AFAS to Ground). The AFAS crew must be able to manually unload 60 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 45 minutes.	Live or Virtual	 Median Unload Time Average Unload Rate Accuracy of Unload	**Time** Time unload finished Time unload started Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct unload Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count System round count	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.

Subject of Experimentation/Testing: AFAS LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Compatibility (Ammunition Systems). The AFAS must be capable of operating with current and developmental munitions packaging systems and automated loading systems (those fielded or in EMD and before the start of AFAS EMD).	Live or Virtual		**Compatibility** Type of automated loading system used (AIRRS, FAAPS, etc.) Type of munitions packaging system used (PLS Flatrack, pallets, etc.) Type of loading operation conducted (Automated, Semi-Automated or Manual)	Not Applicable
Data Entry. The AFAS must be able to automatically read data from a projectile coding system that covers type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Live or Virtual	Percent of correct projectile coding events	**Accuracy** Number of attempts to read projectile data Number of projectiles and data accepted by the system	Event Report PDU Event Report PDU
		Accuracy of reading projectile data	**Accuracy** Record of data read by the projectile coding system by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Event Report PDU Event Report PDU
The AFAS crew must be able to manually enter data into the AFAS system including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.		Accuracy of manual entry of projectile data	**Accuracy** Record of data entered by operator by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight. Record of observed operator input errors	Event Report PDU Event Report PDU Event Report PDU
Rapid Disconnect. The AFAS shall be able to undock from a FARV within 10 seconds with no damage to components, no loss of projectiles, and minimal spillage of fuel and liquid propellant.	Live or Virtual	Median rapid disconnect time	**Time** Time rapid disconnect action completed Time rapid disconnect action initiated Record of damage to components Record of lost projectiles Record of LP spillage Record of fuel spillage	Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Power. The AFAS must be able to accept sufficient power from an external source to enable the AFAS to download ammunition, run diagnostic routine or start the engine.	Live or Virtual		**Capability** Record of instances where external power was required Record of instances were external power was applied and successful	 Event Report PDU Event Report PDU
The AFAS must be able to provide sufficient power to another AFAS or a FARV to enable these vehicles to conduct downloading operations, run diagnostic routines or start their engines.			**Capability** Record of engine starts where AFAS provided external power Record of diagnostics run where AFAS provided external power Record of ammunition downloads operations conducted where AFAS provided external power	 Event Report PDU Event Report PDU Event Report PDU
Communications. The AFAS must provide intervehicular voice communications and digital transfer of data between the AFAS and FARV when connected for resupply/download operations.	Live or Virtual	Percent of correct digital transfers of data during resupply operations	**Completeness** Number of automated resupply operations attempted Number of automated resupply operations completed Records of digital transfer of data Record of intervehicular voice communications during resupply operations	 Event Report PDU Event Report PDU Signal PDU Signal PDU
The POC shall be automatically informed of the current on-board ammunition inventory after each rearm mission and after upload at the LRP.		Percent of inventory status reports sent	**Accuracy** Number of on-board ammunition status changes Type of operation (rearm, upload, download, transload, correction, etc.) Number of on-board ammunition inventory messages sent	 Signal PDU Signal PDU Signal PDU
When the AFAS is docked with a FARV, voice/data communications shall be established and automatically initiated as a part of the mating of two vehicles in preparation for resupply. This link shall provide for the transfer of all control data required to coordinate the transfer processes.		Percent of successful automated docking links	**Compatibility** Number of dockings Number of data exchanges conducted to initiate and control interchange of data between systems	 Event Report PDU Signal PDU
When uploading ammunition and fuel to from a FARV, the Communications Subsystem shall send/receive data to/from the FARV over the communications link per instructions.		Percent of successful data exchanges	**Capability** Number of data exchanges initiated between systems Number of data exchanges conducted between systems	 Signal PDU Signal PDU

Subject of Experimentation/Testing: AFAS LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications (cont.)	Live or Virtual		**Accuracy**	
The on-board ammunition inventory shall be automatically updated after each upload, download, rearm, or other supply transaction which requires changes to on-board inventory information.		Percent of successful ammunition updates	Number of ammunition inventory updates	Event Report PDU
			Number of instances where inventory required update	Event Report PDU
			Reason for update (rearm, upload, download, transload, correction, etc.)	Event Report PDU
			Accuracy	
When conducting resupply operations (Manual and with FARV), the AFAS shall transmit (when downloading) or receive (When uploading) the following information, as applicable: LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.		Accuracy of resupply data exchange	Number of fuzed projectiles by lot, fuze, type and weight transferred by sending system	Signal PDU
			Number of fuzed projectiles by lot, fuze, type and weight accepted by receiving system	Event Report PDU
			Number of LP liters transferred by sending system	Signal PDU
			Number of LP liters accepted by receiving system	Event Report PDU
			Type of operation (rearm, upload, download, transload, correction, etc.)	Signal PDU
			Time	
		Median Inventory Transmission Time	Time docking completed	Event Report PDU
			Time inventory sent	Signal PDU
			Time inventory received	Signal PDU
			Type of resupply operation (upload, download, exchange, etc.)	Signal PDU
			Method of operation (automatic or manual)	Event Report PDU
Decision Aid Capability. The AFAS must have an embedded decision aid capability to assist the crew in making tactical decisions associated with conducting and managing resupply and support operations.	Live or Virtual		**Capability**	
			Number of resupply and support operations conducted with Decision Aids	Event Report PDU
			Number of resupply and support operations conducted without Decision Aids	Event Report PDU
			Crew comments on operations conducted with and without Decision Aids	X
Docking under cover. The AFAS shall be able to dock with a FARV without requiring the crew to leave the crew compartment.	Live or Virtual		**Capability**	
			Record of dockings with crew out of compartment	Event Report PDU
			Record of dockings with crew in compartment	Event Report PDU
Undocking under cover. The AFAS shall be able to undock with a FARV without requiring the crew to leave the crew compartment.	Live or Virtual		**Capability**	
			Record of undockings with crew out of compartment	Event Report PDU
			Record of undockings with crew in compartment	Event Report PDU

Subject of Experimentation/Testing: AFAS LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Rearm/Resupply Mission Cycle Operations. In order to provide timely resupply to the maneuver forces, AFAS when operating at the Operational Mode Summary/Mission Profile (OMS/MP), with FARV not available and to survive on the battlefield, the AFAS must minimize the time required to complete a rearm/resupply mission cycle with efficient and effective operations including travel to and from the LRP and loading operations while at the LRP.	Live or Virtual		**Time**	
		Median Travel Time to LRP	Time arrived the LRP Time departed the LRP	Entity State PDU Entity State PDU
		Median Time Required to Conduct Resupply Operations	Time resupply operations stopped Time resupply operations started	Event Report PDU Event Report PDU
		Median Travel Time from LRP	Time AFAS arrived at position Time AFAS departed LRP	Entity State PDU Entity State PDU
		Average Distance Traveled to LRP	Odometer reading when arrived at LRP Odometer reading when started for LRP	Event Report PDU Event Report PDU
		Average Distance Traveled from LRP	Odometer reading when arrived from LRP Odometer reading when departed LRP	Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS LRP Operations

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** A DIS Virtual Environment would allow evaluation of the tactics, techniques and procedures and key technologies available to support and conduct LRP operations. It would also permit evaluation and analysis of different technologies and capabilities potentially available to support LRP operations. The capabilities of the Advanced Integrated Robotics Rearm System (AIRRS) or other technologies to automate some ammunition processing tasks presently done by crew members could be assessed from an operational perspective. The system could be looked at for integration of various levels of automation, expert (decision aids) systems and controls/displays and their impact on the operational effectiveness on the battlefield. Assessment of the adequacy, maturity and compatibility of ammunition transfer operations and the AIRRS system could be made. Selection and development of technologies could be further investigated to determine additional technologies or combination of technologies to pursue. Demonstration of the achievability of the new technologies being applied to the AFAS (automation, advanced propellant handling, ammunition management, and automated ammunition transfer) could also be made.

2.1 Stated specifications:

- Upload Rate (Supply Point to AFAS)
- Unload Rate (AFAS to Ground)
- Compatibility (Ammunition Systems)
- Decision Aid Capability
- Communications
- Data Entry
- Docking Under Cover
- Undocking Under Cover
- Power
- Rapid Disconnect
- Rearm/Resupply Mission Cycle Operations

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 **Sample Experiment.** A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the AFAS System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the AFAS simulator software has some on-board AIRRS-like, manual and semiautomated rearm/refuel/resupply capabilities, the impact on overall system and crew capability to meet battlefield requirements may be determined and evaluated for their benefit or detriment to mission completion. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the AFAS specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Median Times of Upload and Unload Operations with and without AIRRS-like capabilities
- Average Rate of Upload and Unload Operations with and without AIRRS-like capabilities
- Accuracy of Upload and Unload Operations with and without AIRRS-like capabilities
- Median Times required to conduct LRP Operations with and without AIRRS-like capabilities
- Compatibility with ammunition systems
- Number of missions completed
- Number and type of upload and unload operations conducted
- Number and types of projectile/fuze combinations resupplied
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to resupply operations
- Number and type of manual upload and unload operations conducted
- Number of rapid disconnect operations conducted

3. **Required Resources.** *To support experimentation and testing in the areas identified above the following resources are required:*

Subject of Experimentation/Testing: AFAS LRP Operations

- One AFAS crew to man an AFAS simulator
- One AFAS crew to man an AFAS simulator with AIRRS-like capabilities
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software with AIRRS-like capabilities
- One AFAS SAFOR to support paired howitzer operations
- One FARV SAFOR to support AFAS-to-FARV docking operations
- Several SAFOR PLS CCL Flatracks in various configurations (full, partial and empty) to support resupply operations.
- One SAFOR PLS Truck to support LRP Operations
- One SAFOR fuel truck to support LRP refueling operations
- Various power assisted and hand tools for the AFAS crew members to use in supporting LRP operations
- One FARV SAFOR with AIRRS-like add-on capabilities at the LRP
- A Time Ordered Events List (TOEL)

Subject of Experimentation/Testing: FARV LRP Operations

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual/Assisted Tasks. The FARV shall automate as practicable (to meet upload time requirements) the processing of munitions to include actions delineated below: 1. Open fuze crates 2. Record fuze lot 3. Inspect fuze 4. Break projectile pallets 5. Remove projectile rotating band grommets and lifting plug 6. Remove projectile rocket motor or basebleed nozzle caps 7. Replace projectile nozzle caps with vapor barriers 8. Record projectile lot 9. Inspect projectile 10. Insert fuze 11. Weigh projectile/fuze combination 12. Mark projectile (type, fuze, weight, projectile lot, fuze ,lot) 13. Record all shell/fuze data in the onboard computerized inventory management system 14. Placed fuzed projectile onto loading mechanism	Live	Median Manual Task Upload Time	**Time** Time upload stopped Time upload started Record of manual tasks	 X X X
		Average Number of Rounds Loaded	**Quantity** Number of rounds remaining on PLS flatrack Number of rounds on PLS flatrack at start Record of system inventory by projectile and fuze, lot, type, quantity and fuzed projectile weight. Type of upload (manual or semiautomated)	 X X X X
		Average Loading Rate (Manual)	**Rate** Number of projectiles loaded Time required to load projectiles	 X X
		Median Semiautomated Task Upload Time	**Time** Time upload stopped Time upload started Record of manual tasks performed Record of automated tasks performed	 X X X X
		Average Number of Rounds Loaded	**Quantity** Number of rounds remaining on PLS flatrack Number of rounds on PLS flatrack at start Record of system inventory by projectile and fuze, lot, type, quantity and fuzed projectile weight. Type of upload (manual or semiautomated)	 X X X X
		Average Loading Rate (Semiautomated)	**Rate** Number of projectiles loaded Time required to load projectiles	 X X

Subject of Experimentation/Testing: FARV LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Upload Rate (Supply Point to FARV). Upload 130 complete rounds in less than 65 minutes from a Combat Configured Load (CCL) on a PLS truck or grounded flatrack. At this resupply point as part of the upload process, the FARV personnel shall prepare the ammunition for storage aboard the FARV.	Live or Virtual	 Median Time of Upload	**Time** Time upload finished Time upload started Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
		Average Upload Rate	**Rate** Total time required to conduct upload Number of rounds loaded Number of liters LP propellant loaded Type of upload (Fully Automated, Semi-Automated or Manual) Number of crew members	
		Accuracy of Upload	**Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	
		Median Time Required to Conduct LRP Operations	**Time** Time departed LRP Time arrived LRP Record of LRP activity Number of projectiles uploaded, unloaded, transferred, exchanged or downloaded.	

Subject of Experimentation/Testing: FARV LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Unload (FARV to Ground). The FARV must have the capability to automatically unload 130 complete rounds (fuzed projectiles and LP propellant to containers) to a CCL flatrack or to the ground in less than 30 minutes. The FARV crew must be able to manually unload 130 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 90 minutes	Live or Virtual	Median Unload Time Average Unload Rate Accuracy of Unload	**Time** Time unload finished Time unload started Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Rate** Total time required to conduct unload Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members **Accuracy** Actual round count by projectile fuze combination, and fuze and projectile lot System round count by projectile fuze combination, and fuze and projectile lot	A combination of the Service Request PDU, Resupply Offer PDU, Resupply Received PDU, Resupply Cancel PDU and Event Report PDU can accommodate the data elements for this function.
Compatibility (Ammunition Systems). The FARV must be capable of operating with current and developmental munitions packaging systems and automated loading systems (those fielded or in EMD and before the start of FARV EMD).	Live or Virtual		**Compatibility** Type of automated loading system used (AIRRS, FAAPS, etc.) Type of munitions packaging system used (PLS Flatrack, pallets, etc.) Type of loading operation conducted (Automated, Semi-Automated or Manual)	Not Applicable

Subject of Experimentation/Testing: FARV LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Data Entry. The FARV must be able to automatically read data from a projectile coding system that covers type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Live or Virtual		**Accuracy**	
		Percent of correct projectile coding events	Number of attempts to read projectile data	Event Report PDU
			Number of projectiles and data accepted by the system	Event Report PDU
			Accuracy	
		Accuracy of reading projectile data	Record of data read by the projectile coding system by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Event Report PDU
			Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Event Report PDU
			Accuracy	
The FARV crew must be able to manually enter data into the FARV system including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.		Accuracy of manual entry of projectile data	Record of data entered by operator by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight	Event Report PDU
			Record of actual projectile data by type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Event Report PDU
			Record of observed operator input errors	Event Report PDU
Rapid Disconnect. The FARV shall be able to undock from a FARV within 10 seconds with no damage to components, no loss of projectiles, and minimal spillage of fuel and liquid propellant.	Live or Virtual		**Time**	
		Median rapid disconnect time	Time rapid disconnect action completed	Event Report PDU
			Time rapid disconnect action initiated	Event Report PDU
			Record of damage to components	Event Report PDU
			Record of lost projectiles	Event Report PDU
			Record of LP spillage	Event Report PDU
			Record of fuel spillage	Event Report PDU
Power. The FARV must be able to accept sufficient power from an external source to enable the FARV to download ammunition, run diagnostic routine or start the engine.	Live or Virtual		**Capability**	
			Record of instances where external power was required	Event Report PDU
			Record of instances were external power was applied and successful	Event Report PDU

Subject of Experimentation/Testing: FARV LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. The FARV must provide intervehicular voice communications and digital transfer of data between the FARV and AFAS, or another FARV when connected for resupply/download operations.	Live or Virtual	Percent of correct digital transfers of data during resupply operations	**Completeness**	
			Number of automated resupply operations attempted	Event Report PDU
			Number of automated resupply operations completed	Event Report PDU
			Records of digital transfer of data	Signal PDU
			Record of intervehicular voice communications during resupply operations	Signal PDU
The POC shall be automatically informed of the current on-board ammunition inventory after each rearm mission and after upload at the LRP.		Percent of inventory status reports sent	**Accuracy**	
			Number of on-board ammunition status changes	Signal PDU
			Type of operation (rearm, upload, download, transload, correction, etc.)	Signal PDU
			Number of on-board ammunition inventory messages sent	Signal PDU
When the FARV is docked with an AFAS or another FARV, voice/data communications shall be established and automatically initiated as a part of the mating of two vehicles in preparation for resupply. This link shall provide for the transfer of all control data required to coordinate the transfer processes.		Percent of successful automated docking links	**Compatibility**	
			Number of dockings	Event Report PDU
			Number of data exchanges conducted to initiate and control interchange of data between systems	Signal PDU
When uploading ammunition and fuel to the AFAS or another FARV, the Communications Subsystem shall send/receive data to/from the AFAS or another FARV over the communications link per instructions of the Mission Management and Control Subsystem.		Percent of successful data exchanges	**Capability**	
			Number of data exchanges initiated between systems	Signal PDU
			Number of data exchanges conducted between systems	Signal PDU
The on-board ammunition inventory shall be automatically updated after each upload, download, rearm, or other supply transaction which requires changes to on-board inventory information.		Percent of successful ammunition updates	**Accuracy**	
			Number of ammunition inventory updates	Event Report PDU
			Number of instances where inventory required update	Event Report PDU
			Reason for update (rearm, upload, download, transload, correction, etc.)	Event Report PDU
When conducting resupply operations (Manual and with FARV or AFAS), the FARV shall transmit (when downloading) or receive (When uploading) the following information, as applicable: LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.		Accuracy of resupply data exchange	**Accuracy**	
			Number of fuzed projectiles by lot, fuze, type and weight transferred by sending system	Signal PDU
			Number of fuzed projectiles by lot, fuze, type and weight accepted by receiving system	Event Report PDU
			Number of LP liters transferred by sending system	Signal PDU
			Number of LP liters accepted by receiving system	Event Report PDU
			Type of operation (rearm, upload, download, transload, correction, etc.)	Signal PDU

Subject of Experimentation/Testing: FARV LRP Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Decision Aid Capability. The FARV must have an embedded decision aid capability to assist the crew in making tactical decisions associated with conducting and managing resupply and support operations.	Live or Virtual		**Capability**	
			Number of resupply and support operations conducted with Decision Aids	Event Report PDU
			Number of resupply and support operations conducted without Decision Aids	Event Report PDU
			Crew comments on operations conducted with and without Decision Aids	X
Docking under cover. The AFAS shall be able to dock with a FARV without requiring the crew to leave the crew compartment.	Live or Virtual		**Capability**	
			Record of dockings with crew out of compartment	Event Report PDU
			Record of dockings with crew in compartment	Event Report PDU
Undocking under cover. The AFAS shall be able to undock with a FARV without requiring the crew to leave the crew compartment.	Live or Virtual		**Capability**	
			Record of undockings with crew out of compartment	Event Report PDU
			Record of undockings with crew in compartment	Event Report PDU
Rearm/Resupply Mission Cycle Operations. In order to provide timely resupply to the AFAS or another FARV operating at the Operational Mode Summary/Mission Profile (OMS/MP) and to survive on the battlefield, the FARV must minimize the time required to complete a rearm/resupply mission cycle with efficient and effective operations including travel to and from the LRP and loading operations while at the LRP.	Live or Virtual		**Time**	
		Median Travel Time to LRP	Time arrived the LRP	Entity State PDU
			Time departed the LRP	Entity State PDU
		Median Time Required to Conduct Resupply Operations	Time resupply operations stopped	Event Report PDU
			Time resupply operations started	Event Report PDU
		Median Travel Time from LRP	Time FARV arrived at position	Entity State PDU
			Time FARV departed LRP	Entity State PDU
		Average Distance Traveled to LRP	Odometer reading when arrived at LRP	Event Report PDU
			Odometer reading when started for LRP	Event Report PDU
		Average Distance Traveled from LRP	Odometer reading when arrived from LRP	Event Report PDU
			Odometer reading when departed LRP	Event Report PDU

Subject of Experimentation/Testing: FARV LRP Operations

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** A DIS Virtual Environment would allow evaluation of the tactics, techniques and procedures and key technologies available to support and conduct LRP operations. It would also permit evaluation and analysis of different technologies and capabilities potentially available to support LRP operations. The capabilities of the Advanced Integrated Robotics Rearm System (AIRRS) or other technologies to automate some ammunition processing tasks presently done by crew members could be assessed from an operational perspective. The system could be looked at for integration of various levels of automation, expert (decision aids) systems and controls/displays and their impact on the operational effectiveness on the battlefield. Assessment of the adequacy, maturity and compatibility of ammunition transfer operations and the AIRRS system could be made. Selection and development of technologies could be further investigated to determine additional technologies or combination of technologies to pursue. Demonstration of the achievability of the new technologies being applied to the FARV (automation, advanced propellant handling, ammunition management, and automated ammunition transfer) could also be made.

2.1 Stated specifications:

- Upload Rate (Supply Point to FARV)
- Unload Rate (FARV to Ground)
- Compatibility (Ammunition Systems)
- Decision Aid Capability
- Communications
- Data Entry
- Docking Under Cover
- Undocking Under Cover
- Power
- Rapid Disconnect
- Rearm/Resupply Mission Cycle Operations

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the FARV System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the FARV simulator software has some on-board AIRRS-like, manual and semiautomated rearm/refuel/resupply capabilities, the impact on overall system and crew capability to meet battlefield requirements may be determined and evaluated for their benefit or detriment to mission completion Placing the FARV simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the FARV specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Median Times of Upload and Unload Operations with and without AIRRS-like capabilities
- Average Rate of Upload and Unload Operations with and without AIRRS-like capabilities
- Accuracy of Upload and Unload Operations with and without AIRRS-like capabilities
- Median Times required to conduct LRP Operations with and without AIRRS-like capabilities
- Compatibility with Ammunition systems
- Number of missions completed
- Number and type of upload and unload operations conducted
- Number and types of projectile/fuze combinations resupplied
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to resupply operations
- Number and type of manual upload and unload operations conducted
- Number of rapid disconnect operations conducted

Subject of Experimentation/Testing: FARV LRP Operations

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One FARV crew to man an FARV simulator
- One FARV crew to man an FARV simulator with AIRRS-like capabilities
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software
- One FARV simulator equipped with radios, modems, crew stations, crew displays, supporting software with AIRRS-like capabilities
- One AFAS SAFOR to support AFAS to FARV resupply/rearm/refuel and docking operations
- One FARV SAFOR to support FARV-to-FARV docking operations
- Several SAFOR PLS CCL Flatracks in various configurations (full, partial and empty) to support resupply operations.
- One SAFOR PLS Truck to support LRP Operations
- One SAFOR fuel truck to support LRP refueling operations
- Various power assisted and hand tools for the FARV crew members to use in supporting LRP operations
- One FARV SAFOR with AIRRS-like add-on capabilities
- A Time Ordered Events List (TOEL)

Subject of Experimentation/Testing: AFAS Degraded Operations

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Download (AFAS to FARV). The AFAS must allow the crew to manually unload 60 complete rounds (fuzed projectiles and LP propellant) to a FARV, a CCL flatrack or the ground (LP to containers) in less than 45 minutes.	Live or Virtual		**Time**	
		Median Download Time	Time when the FARV is again capable of maneuver (Stop Time)	Event Report PDU
			Time when the system initiates a maneuver to conduct docking (Start Time)	Event Report PDU
			Number of rounds loaded	Resupply Received PDU
			Number of liters LP propellant loaded	Resupply Received PDU
			Time stopped transfer of 2 Copperheads	Event Report PDU
			Time started transfer of 2 Copperheads	Event Report PDU
			Rate	
		Average Download Rate	Total time required to conduct download	Event Report PDU
			Number of rounds downloaded	Resupply Received PDU
			Number of liters LP propellant downloaded	Resupply Received PDU
			Type of download (Automated or Manual)	Event Report PDU
			Accuracy	
		Accuracy of Download	Actual round count by projectile/fuze combination	Event Report PDU
			System round count	Event Report PDU
Unload (AFAS to Ground). The AFAS crew must be able to manually unload 60 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 45 minutes.	Live or Virtual		**Time**	
		Median Unload Time	Time unload finished	Event Report PDU
			Time unload started	Event Report PDU
			Number of rounds unloaded	Resupply Received PDU
			Number of liters LP propellant unloaded	Resupply Received PDU
			Type of unload (Fully Automated, Semi-Automated or Manual)	Event Report PDU
			Number of crew members	Event Report PDU
			Rate	
		Average Unload Rate	Total time required to conduct unload	Event Report PDU
			Number of rounds unloaded	Resupply Received PDU
			Number of liters LP propellant unloaded	Resupply Received PDU
			Type of unload (Fully Automated, Semi-Automated or Manual)	Event Report PDU
			Number of crew members	Event Report PDU
			Accuracy	
		Accuracy of Unload	Actual round count	Event Report PDU
			System round count	Event Report PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual upload. If the FARV is unavailable, the AFAS must be capable of being manually uploaded with 155mm ammunition and propellant (from combat configured loads on *palletized loading system trucks or* grounded flatracks) at a median rate of at least one complete round per minute. This function includes required processing of fuzes and projectiles plus data entry (LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.).	Live or Virtual		**Time**	
		Median Time of Upload	Time upload finished	Event Report PDU
			Time upload started	Event Report PDU
			Number of rounds loaded	Resupply Received PDU
			Number of liters LP propellant loaded	Resupply Received PDU
			Type of upload (Fully Automated, Semi-Automated or Manual)	Event Report PDU
			Number of crew members	Event Report PDU
			Rate	
		Average Upload Rate	Total time required to conduct upload	Event Report PDU
			Number of rounds loaded	Resupply Received PDU
			Number of liters LP propellant loaded	Resupply Received PDU
			Type of upload (Fully Automated, Semi-Automated or Manual)	Event Report PDU
			Number of crew members	Event Report PDU
			Accuracy	
		Accuracy of Upload	Actual round count	Event Report PDU
			System round count	Event Report PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. When conducting resupply operations (Manual and with FARV), the AFAS shall transmit (when downloading) or receive (When uploading) the following information, as applicable: LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot. If the docking link is inoperative, data must be entered manually or with the projectile code scanner.	Live or Virtual		**Time**	
		Median Inventory Transmission Time	Time docking completed	Signal PDU
			Time inventory sent	Signal PDU
			Time inventory received	Signal PDU
			Type of resupply operation (upload, download, exchange, etc.)	Signal PDU
			Method of operation (automatic or manual)	Signal PDU
			Accuracy	
		Accuracy of inventory	Quantity of LP propellant reported (Sender)	Signal PDU
			Actual quantity LP propellant loaded (Receiver)	Event Report PDU
			Record of projectile with fuze by lot, number and fuzed weight reported (Sender)	Signal PDU
			Actual number of projectile with fuze by lot, number and fuzed weight loaded (Receiver)	Event Report PDU
			Record of inventory entered if manual entry	Event Report PDU
			Record of inventory if projectile code scanner used	Event Report PDU
			Capability	
If a single failure occurs, the remaining radio shall be dedicated to the digital net.			Record of instances where one or both radios were inoperative	Transmitter and Receiver PDUs
If both radios fail, the howitzer shall either operate with another howitzer in a subordinate role if the tactical situation warrants or shall be considered out of action.			Record of when the AFAS operates in a subordinate role when radios are inoperative	Event Report PDU
			Record of when the AFAS is out of action due to inoperable radios	Event Report PDU
			Capability	
The AFAS must provide for voice communications between crew stations.			Record of intrasection voice communications	Signal PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual Data Entry. The AFAS crew must be able to manually enter data into the AFAS system including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight.	Live or Virtual	Accuracy of Manual Data Entry	**Accuracy** Record of data entered manually by type of projectile and fuze, lot, quantity of propellant and fuzed projectile weight pounds or square weight Record of actual inventory by type of projectile and fuze, lot, quantity of propellant and fuzed projectile weight pounds or square weight Record of operator input errors	Event Report PDU Event Report PDU Event Report PDU
The AFAS must be capable of accepting fire commands for manual entry by the crew that are received over the battery command (voice) net.			**Capability** Record of fire missions and commands received over the battery command (voice) net	Signal PDU
		Median transmissio n Time for Voice Fire Missions	**Time** Time voice fire mission received Time voice fire mission initiated	Event Report PDU Event Report PDU
If projectiles are uncoded, then projectile square weight will be used and entered manually into the system.		Accuracy of manually entered projectile square weight	**Accuracy** Record of projectile square weight entered Record of system inventory of projectile square weight by projectile	Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Power. The AFAS must be able to accept sufficient power from an external source to enable the AFAS to download ammunition, run diagnostics routines or to start the engine.	Live or Virtual		**Capability** Record of engine starts from external power Record of diagnostics run from external power Record of ammunition downloads operations conducted with external power	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The AFAS must be able to provide sufficient power to another AFAS or a FARV to enable these vehicles to conduct downloading operations, run diagnostic routines or start their engines.			**Capability** Record of engine starts where AFAS provided external power Record of diagnostics run where AFAS provided external power Record of ammunition downloads operations conducted where AFAS provided external power	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The AFAS must be able to produce a reduced level of power which is capable of powering on-board computer, communications, position/navigation and survivability systems (less main armament and NBC overpressure) and starting the engine for at least 6 hours.		Median Time Reduced Power Level Operations were Conducted	**Time** Time reduced power level operations stopped Time reduced power level operations initiated Record of reduced power level operations Reason for reduced power level operations	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
Muzzle Velocity. The system must be able to accept muzzle velocity variation (MVV) if the on-board system for determining round-to-round variation in muzzle velocity is not available.	Live or Virtual		**Capability** Record of MVV input by AFAS Record of MVV input sent to AFAS Reason for MVV input	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
Position and Azimuth. When the AFAS is operating as a senior or subordinate howitzer, it shall be capable of providing location and orientation data to a subordinate howitzer that has lost the capability to provide this data for itself when the howitzers are separated by up to 1 km (0.62 mi). Function will be completed by crew members from their work stations and within two minutes after the howitzers have stopped in their respective firing positions with no more than 10 percent degradation in pointing accuracy of the subordinate howitzer.	Virtual or Live	Median Time to Provide Location and Orientation Data Average Percent Error in Azimuth and Location	**Time** Time last howitzer stopped in firing position Time first howitzer stopped in firing position Time degraded howitzer was provided location and orientation data **Accuracy** Surveyed location of degraded howitzer Location provided by senior/subordinate howitzer to the degraded howitzer Surveyed azimuth Azimuth provided by senior/subordinate howitzer to the degraded howitzer	Entity State PDU Entity State PDU Signal PDU Event Report or Entity State PDU Signal PDU Event Report or Entity State PDU Signal PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (*X = Unsupportable by DIS PDUs*)
Projectile weight. When projectiles in the AFAS magazine have not been weighed and coded to the nearest 0.05 kg (0.1 lb), the AFAS shall compute ballistics based on the current square method of weighing projectiles.	Live or Virtual	Accuracy of manually entered data	**Accuracy** Record of projectile square weight entered Record of system inventory by square weight by projectile **Capability** Record of data computed and fired using the projectile square weight	X or Event Report PDU X or Event Report PDU X or Event Report PDU
Fire Control. When the AFAS is operating as a senior or subordinate howitzer, the AFAS shall be capable of providing tactical and technical fire control for itself and one subordinate howitzer at the direction of the POC when the two howitzers are separated by *no* more than 1 km (0.62 mi).	Live or Virtual	Average Distance Between Senior/Subordinate Howitzer and Degraded Howitzer	**Capability** Record of tactical fire control data furnished Record of technical fire control data furnished **Distance** Location of senior/subordinate howitzer Location of degraded howitzer	Signal PDU Signal PDU Entity State PDU Entity State PDU
When the AFAS is operating as a senior or subordinate howitzer, the AFAS shall be capable of accepting tactical and technical fire control data and instructions from a senior howitzer at the direction of the POC when the two howitzers are separated by no more than 1 km (0.62 mi).		Average Distance Between Senior/Subordinate Howitzer and Degraded Howitzer	**Capability** Record of tactical fire control data received Record of technical fire control data received **Distance** Location of senior/subordinate howitzer Location of degraded howitzer	Signal PDU Signal PDU Entity State PDU Entity State PDU
Operations. Under conditions of reduced manning, the AFAS must be capable of performing its primary missions (shoot, move, communicate, and survive) with two crew members for limited periods (up to 4 hours).	Live or Virtual	Median Time of Reduced Manning Operations	**Time** Time reduced manning stopped Time reduced manning started Record of fire missions conducted Record of AFAS movement Record of voice and digital communications Number of crew members operating system	Event Report PDU Event Report PDU Signal PDU Entity State PDU Signal PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Hydraulic Loss. In the event of loss of hydraulic power, the AFAS must be able to manually orient the tube to the proper firing azimuth and quadrant to complete the fire mission.	Live or Virtual		**Capability** Record of hydraulic power loss Record of manual data (azimuth and elevation) set to complete fire mission Record of computed firing data	 X or Event Report PDU X or Event Report PDU X or Event Report PDU
Gun Drive Servos. In the event of loss of gun drive servos, the AFAS must be able to manually orient the tube to the proper firing azimuth and quadrant to complete the fire mission.	Live or Virtual		**Capability** Record of hydraulic power loss Record of manual data (azimuth and elevation) set to complete fire mission Record of computed firing data	 X or Event Report PDU X or Event Report PDU X or Event Report PDU
Towing. The AFAS shall be capable of being towed in the forward direction by the M88A1, a FARV, or another AFAS, without using a "hold back" vehicle. The system shall be capable of towing a FARV or an AFAS at forward speeds of at least 20 km per hour for at least 15 km on a dry, level, hard surface, with no damage to either the towing vehicle or the vehicle being towed. The system shall require no special preparation prior to towing (e.g., disconnection of final drives).	Live or Virtual	Median Time for Towing Operations	**Time** Time towing stopped Time towing started	 X or Event Report PDU X or Event Report PDU
		Average Straight Line Towing Distance	**Distance** Location towing stopped Location towing started	 X or Event Report PDU X or Event Report PDU
		Average Distance traveled During Towing Operations	Odometer reading when towing completed Odometer reading when towing started	X or Event Report PDU X or Event Report PDU
The AFAS must be able to be towed and recovered by organic recovery assets (projected to be the M88A1).			**Capability** Record of recovery by vehicle model (M88A1, AFAS, FARV, etc.)	 X or Event Report PDU

Subject of Experimentation/Testing: AFAS Degraded Operations

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. Based on the results derived from the above matrix, DIS experimentation/testing appears feasible to assess the operational and technical tradeoffs in the following AFAS stated specifications and other aspects of performance derived by the analysis: A DIS Virtual Environment would allow demonstration of key specifications and requirements related to manual and degraded operations. It would permit evaluation of degraded resupply operations including unpowered download, manual upload and unload operations and workload task analysis. Evaluation of manual tasks and degraded operations could assess the impact of the AFAS's ability and the crew's ability to conduct sustained battlefield operations. Experiments could evaluate selection and development of technologies including alternative power sources and varying degrees of robotics that have potential application to improve howitzer vehicle combat operations, maintainability and sustainment. Demonstrate the suitability of the new technologies being applied to the AFAS (automation, advanced propellant handling, ammunition management, and ammunition transfer and docking).

2.1 Stated specifications:

- Unpowered Download Rate (AFAS to FARV)
- Manual Unload Rate (AFAS to Ground)
- Manual Upload Rate (PLS to AFAS)
- Communications
- Manual Data Entry
- Power
- Position and Location
- Operations
- Hydraulic Loss
- Towing

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the AFAS System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the AFAS simulator software has a manual download, unload and upload capability, the impact on overall system and crew capability to meet battlefield requirements may be determined. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the AFAS specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Median manual download, unload and upload times
- Average manual download, unload and upload rates
- Accuracy of inventories conducted during manual or degraded operations
- Number and quality of manual data entries and inventories
- Number of intrasection communications
- Number of digital communications conducted
- Number of resupply operations completed by each AFAS
- Number of resupply trips to the LRP completed by each AFAS when FARV is unavailable
- Number of missions not fired due to ammunition, fuel or LP propellant shortages
- Number of projectiles fired by type
- Number of entries where projectile square weight was entered
- Number of instances where external power was required to conduct ammunition download operations, run diagnostics and conduct engine starts
- Amount of time system was operated at a reduced power level
- Amount of time system was operated at reduced manning levels
- Number of instances where loss of hydraulics resulted in manual operations being conducted
- Number and distance traveled for towing operations
- Number of instances where the AFAS towed another vehicle

Subject of Experimentation/Testing: AFAS Degraded Operations

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays and supporting software to conduct fire missions.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire, update information bases on fire support coordination measures, battlefield geometry, meteorological data, and preplanned targets.
- One AFAS SAFOR to support degraded power operations, docking, towing and resupply operations
- Several PLS CCL Flatracks in various configurations (full, partial and empty) to support resupply operations.
- One SAFOR fuel truck to support LRP refueling operations
- One M88A1 SAFOR for towing operations
- One FARV SAFOR to support LRP, paired operations, docking, resupply and towing operations
- Threat SAFOR operations order
- Threat SAFOR to execute the order
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

Subject of Experimentation/Testing: FARV Degraded Operations

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Download (AFAS to FARV). When required for maintenance or other operational reasons, fuzed projectiles and liquid propellant shall be capable of being manually downloaded at a rate of at least 130 complete rounds in less than 90 minutes with the system in an unpowered state.	Live or Virtual	Median Download Time	**Time** Time when the FARV is again capable of. ɪnaneuver (Stop Time) Time when the system initiates a maneuver to conduct docking (Start Time) Number of rounds loaded Number of liters LP propellant loaded Time stopped transfer of 2 Copperheads Time started transfer of 2 Copperheads	Event Report PDU Event Report PDU Resupply Received PDU Resupply Received PDU Event Report PDU Event Report PDU
		Average Download Rate	**Rate** Total time required to conduct download Number of rounds downloaded Number of liters LP propellant downloaded Type of download (Automated or Manual)	Event Report PDU Resupply Received PDU Resupply Received PDU Event Report PDU
		Accuracy of Download	**Accuracy** Actual round count by projectile/fuze combination System round count	Event Report PDU Event Report PDU
Unload (FARV to Ground). The FARV crew must be able to manually unload 130 complete rounds (fuzed projectiles and LP propellant) to a CCL flatrack or the ground (LP to containers) in less than 90 minutes.	Live and Virtual	Median Unload Time	**Time** Time unload finished Time unload started Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members	Event Report PDU Event Report PDU Resupply Received PDU Resupply Received PDU Event Report PDU Event Report PDU
		Average Unload Rate	**Rate** Total time required to conduct unload Number of rounds unloaded Number of liters LP propellant unloaded Type of unload (Fully Automated, Semi-Automated or Manual) Number of crew members	Event Report PDU Resupply Received PDU Resupply Received PDU Event Report PDU Event Report PDU
		Accuracy of Unload	**Accuracy** Actual round count System round count	Event Report PDU Event Report PDU

Subject of Experimentation/Testing: FARV Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual upload. The FARV must be capable of being manually uploaded with 155mm ammunition and propellant (from combat configured loads on palletized loading system trucks or grounded flatracks) at a median rate of at least one complete round per minute. This function includes required processing of fuzes and projectiles plus data entry (LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.). If projectiles are uncoded, then projectile square weight will be used.	Live and Virtual		**Time**	
		Median Time of Upload	Time upload finished	Event Report PDU
			Time upload started	Event Report PDU
			Number of rounds loaded	Resupply Received PDU
			Number of liters LP propellant loaded	Resupply Received PDU
			Type of upload (Fully Automated, Semi-Automated or Manual)	Event Report PDU
			Number of crew members	Event Report PDU
			Rate	
		Average Upload Rate	Total time required to conduct upload	Event Report PDU
			Number of rounds loaded	Resupply Received PDU
			Number of liters LP propellant loaded	Resupply Received PDU
			Type of upload (Fully Automated, Semi-Automated or Manual)	Event Report PDU
			Number of crew members	Event Report PDU
			Accuracy	
		Accuracy of Upload	Actual round count	Event Report PDU
			System round count	Event Report PDU

Subject of Experimentation/Testing: FARV Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. When conducting resupply operations (Manual and with another FARV or AFAS), the FARV shall transmit (when downloading) or receive (when uploading) the following information, as applicable: LP lot number (if required) and quantity, quantity of fuel, projectile model, projectile lot number, fuzed weight, fuze model and fuze lot.	Live and Virtual		**Time**	
		Median Inventory Transmission Time	Time docking completed	Signal PDU
			Time inventory sent	Signal PDU
			Time inventory received	Signal PDU
			Type of resupply operation (upload, download, exchange, etc.)	Signal PDU
			Method of operation (automatic or manual)	Signal PDU
			Accuracy	
		Accuracy of inventory	Quantity of LP propellant reported (Sender)	Signal PDU
			Actual quantity LP propellant loaded (Receiver)	Event Report PDU
			Record of projectile with fuze by lot, number and fuzed weight reported (Sender)	Signal PDU
			Actual number of projectile with fuze by lot, number and fuzed weight loaded (Receiver)	Event Report PDU
			Record of inventory entered if manual entry	Event Report PDU
			Record of inventory if projectile code scanner used	Event Report PDU
			Capability	
If a single failure occurs, the remaining radio shall be dedicated to the digital net.			Record of instances where one or both radios were inoperative	Transmitter PDU and Receiver PDU
If both radios fail, the howitzer shall either operate with another howitzer in a subordinate role if the tactical situation warrants or shall be considered out of action.			Record of when the AFAS operates in a subordinate role when radios are inoperative	Event Report PDU
			Record of when the AFAS is out of action due to inoperable radios	Event Report PDU
			Capability	
The AFAS must provide for voice communications between crew stations.			Record of intrasection voice communications	Signal PDU

Subject of Experimentation/Testing: FARV Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Manual Data Entry. The FARV crew must be able to manually enter data into the FARV system including type of projectile, type of fuze, lot number of fuze, lot number of propellant, lot number of projectile, and fuzed projectile weight (by square weight and by pound).	Live and Virtual		**Accuracy**	
		Accuracy of Manual Data Entry	Record of data entered manually by type of projectile and fuze, lot, quantity of propellant and fuzed projectile weight pounds or square weight	Event Report PDU
			Record of actual inventory by type of projectile and fuze, lot, quantity of propellant and fuzed projectile weight pounds or square weight	Event Report PDU
			Capability	
			Record of fire missions and commands received over the battery command (voice) net	Signal PDU
			Time	
		Median transmission Time for Voice Fire Missions	Time voice fire mission received Time voice fire mission initiated	Event Report PDU Event Report PDU
			Accuracy	
If projectiles are uncoded, then projectile square weight will be used and entered manually into the system.		Accuracy of manually entered projectile square weight	Record of projectile square weight entered Record of system inventory of projectile square weight by projectile	Event Report PDU Event Report PDU

Subject of Experimentation/Testing: FARV Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Power. The FARV must be able to accept sufficient power from an external source to enable the FARV to download ammunition, run diagnostics routines or to start the engine.	Live and Virtual		**Capability** Record of engine starts from external power Record of diagnostics run from external power Record of ammunition downloads operations conducted with external power	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The FARV must be able to provide sufficient power to an AFAS or another FARV to enable these vehicles to conduct downloading operations, run diagnostic routines or start their engines.			**Capability** Record of engine starts where FARV provided external power Record of diagnostics run where FARV provided external power Record of ammunition downloads operations conducted where FARV provided external power	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The FARV must be able to produce a reduced level of power which is capable of powering on-board computer, communications, position/navigation and survivability systems (less main armament and NBC overpressure) and starting the engine for at least 6 hours.		Median Time Reduced Power Level Operations were Conducted	**Time** Time reduced power level operations stopped Time reduced power level operations initiated Record of reduced power level operations Reason for reduced power level operations	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs)
Position. The FARV shall be capable of providing location data to another FARV that has lost the capability to provide this data for itself when the FARVs are separated by up to 1 km (0.62 mi). Function will be completed by crew members from their work stations and within two minutes after the vehicles have stopped in their respective positions.	Live and Virtual	Median Time to Provide Location and Orientation Data Average Percent Error in Azimuth and Location	**Time** Time last vehicle stopped in position Time first vehicle stopped in position Time degraded FARV was provided location data **Accuracy** Surveyed location of degraded FARV Location provided by FARV	Entity State PDU Entity State PDU Signal PDU Event Reported PDU or Entity State PDU Signal PDU
Operations. Under conditions of reduced manning, the FARV must be capable of performing its primary missions (resupply, move, communicate, and survive) with two crew members for limited periods (up to 4 hours).	Live and Virtual	Median Time of Reduced Manning Operations	**Time** Time reduced manning stopped Time reduced manning started Record of resupply missions conducted Record of FARV movement Record of voice and digital communications Number of crew members operating system	Event Report PDU Event Report PDU Signal PDU Entity State PDU Signal PDU Event Report PDU

Subject of Experimentation/Testing: FARV Degraded Operations

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Hydraulic Loss. In the event of loss of hydraulic power, the FARV must be able to manually operate critical system functions to complete the mission.	Live and Virtual		**Capability** Record of hydraulic power loss Record of mission complete using manual operation	 X or Event Report PDU X or Event Report PDU
Towing. The FARV shall be capable of being towed in the forward direction by the M88A1, a FARV, or an AFAS, without using a "hold back" vehicle. The system shall be capable of towing a FARV or an AFAS at forward speeds of at least 20 km per hour for at least 15 km on a dry, level, hard surface, with no damage to either the towing vehicle or the vehicle being towed. The system shall require no special preparation prior to towing (e.g., disconnection of final drives).	Live and Virtual	Median Time for Towing Operations	**Time** Time towing stopped Time towing started	 X or Event Report PDU X or Event Report PDU
		Average Straight Line Towing Distance	**Distance** Location towing stopped Location towing started	 X or Event Report PDU X or Event Report PDU
		Average Distance traveled During Towing Operations	Odometer reading when towing completed Odometer reading when towing started	X or Event Report PDU X or Event Report PDU
The FARV must be able to be towed and recovered by organic recovery assets (projected to be the M88A1).			**Capability** Record of recovery by vehicle model (M88A1, AFAS, FARV, etc.)	 X or Event Report PDU

Subject of Experimentation/Testing: FARV Degraded Operations

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. Based on the results derived from the above matrix, DIS experimentation/testing appears feasible to assess the operational and technical tradeoffs in the following FARV stated specifications and other aspects of performance derived by the analysis: A DIS Virtual Environment would allow demonstration of key specifications and requirements related to manual and degraded operations. It would permit evaluation of degraded resupply operations including unpowered download, manual upload and unload operations and workload task analysis. Evaluation of manual tasks and degraded operations could assess the impact of the FARV's ability and the crew's ability to conduct sustained battlefield operations. Evaluate selection and development of technologies including alternative power sources and varying degrees of robotics. Demonstrate the suitability of the new technologies being applied to the FARV (automation, advanced propellant handling, ammunition management, and ammunition transfer and docking).

2.1 Stated specifications:

- Unpowered Download Rate (AFAS to FARV)
- Manual Unload Rate (FARV to Ground)
- Manual Upload Rate (PLS to FARV)
- Communications
- Manual Data Entry
- Power
- Position
- Operations
- Hydraulic Loss
- Towing

2.2 : Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the FARV System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the FARV simulator software has a manual download, unload and upload capability, the impact on overall system and crew capability to meet battlefield requirements may be determined. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the FARV specification. However, the overall impact of design changes can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes:

- Median manual download, unload and upload times
- Average manual download, unload and upload rates
- Accuracy of inventories conducted during manual or degraded operations
- Number and quality of manual data entries and inventories
- Number of intrasection communications
- Number of digital communications conducted
- Number of resupply operations completed by each FARV
- Number of resupply trips to the LRP completed by each FARV
- Number of missions not fired due to ammunition, fuel or LP propellant shortages
- Number of projectiles fired by type
- Number of entries where projectile square weight was entered
- Number of instances where external power was required to conduct ammunition download operations, run diagnostics and conduct engine starts
- Amount of time system was operated at a reduced power level
- Amount of time system was operated at reduced manning levels
- Number of instances where loss of hydraulics resulted in manual operations being conducted
- Number and distance traveled for towing operations
- Number of instances where the FARV towed another vehicle

Subject of Experimentation/Testing: FARV Degraded Operations

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One FARV crew to man an FARV simulator
- One FARV simulator equipped with radios, modems, crew stations, crew displays and supporting software.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire, update information bases on fire support coordination measures, battlefield geometry, meteorological data, and preplanned targets.
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays and supporting software to conduct fire missions
- One AFAS SAFOR to support degraded power operations, docking, towing and resupply operations
- Several PLS CCL Flatracks in various configurations (full, partial and empty) to support resupply operations.
- One SAFOR fuel truck to support LRP refueling operations
- One M88A1 SAFOR for towing operations
- One FARV SAFOR to support LRP, paired operations, docking, resupply and towing operations
- Threat SAFOR operations order
- Threat SAFOR to execute the order
- Friendly force operations order with fire support coordination measures and battlefield geometry
- Friendly SAFOR to execute the order

Subject of Experimentation/Testing. AFAS Crew Size and Military Occupational Specialty (MOS)

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Personnel. The system shall be operated by a three man crew. It is expected that each crew member will possess a 13B MOS code.	AFAS simulator equipped with BCC, radios, modem, intercom, and crew station displays	Mission response time for moving or emplaced AFAS	**Time**	
			Time vehicle stops in firing position	Entity State PDU
			Time fire mission acknowledged by BCC	Event Report PDU
			Time first round fired	Fire PDU
		Number of missions and projectiles fired	**Mission Fired Reports (MFR) transmitted by AFAS to POC**	Event Report PDUs to designate each MFR transmitted
			Projectile type and number fired	Fire and Detonation PDUs
			Crew warning enunciators activated	Event Report PDU
		Detection and warning of violations of fire support coordination measures and friendly battlefield geometry.	**Location**	
			Location of fire support coordination measures and battlefield geometry	Signal PDU
			Location of target in call for fire	Detonation PDU
			Location of AFAS howitzer	Fire PDU
			Location of projectile trajectory (x,y,z axes)	Entity State PDU
		Outcome of indirect fire engagements	**Effects on Target**	
			Vehicle and force identification	Detonation PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU
			Area illuminated	Suggest extension of DIS standards to allow representing illumination as an environmental entity, much like a smoke cloud is handled now.

Subject of Experimentation/Testing. AFAS Crew Size

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Reduced Crew. The system shall provide the capability for conducting its primary functions (shoot, move, communicate, and survive) with two crew members for up to 4 hours with no degradation in performance.	AFAS simulator equipped with BCC, radios, modem, intercom, and crew station displays	Mission response time for moving or emplaced AFAS	**Time**	
			Time crew reduced from 3 to 2 crew members	X (Manual Entry)
			Time vehicle stops in firing position	Entity State PDU
			Time fire mission acknowledged by BCC	Event Report PDU
		Number of missions and projectiles fired	Time first round fired	Fire PDU
			Mission Fired Reports (MFR) transmitted by AFAS to POC	Event Report PDUs to designate each MFR transmitted
			Projectile type and number fired	Fire and Detonation PDUs
		Detection and warning of violations of fire support coordination measures and friendly battlefield geometry.	**Crew warning enunciators activated**	Event Report PDU
			Location	
			Location of fire support coordination measures and battlefield geometry	Signal PDU
			Location of target in call for fire	Detonation PDU
			Location of AFAS howitzer	Fire PDU
		Outcome of indirect fire engagements	Location of projectile trajectory (x,y,z axes)	Entity State PDU
			Effects on Target	
			Vehicle and force identification	Detonation PDU
			Mobility kills	Entity State PDU
			Fire control kills	Entity State PDU
			Communication kills	Receiver PDU
			Area visually obscured	Entity State PDU
			Area illuminated	Suggest extension of DIS standards to allow representing illumination as an environmental entity, much like a smoke cloud is handled now.

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. DIS experimentation and testing appears feasible to assess the operational and technical tradeoffs involved in varying AFAS crew size. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to changes in crew size:

- Number of threat entities sustaining combat damage by AFAS indirect fire by projectile type
- Number of threat entities blinded by AFAS smoke
- Number of threat entities illuminated by AFAS illumination missions.
- Number of AFASs and FARVs sustaining combat damage
- Number and type of missions fired (i.e. standard, MRSI, Copperhead)
- Number of projectiles fired by type
- Number of fratricides resulting from violation of fire support coordination measures and battlefield geometry
- Mission response time by mission for AFAS while emplaced
- Mission response time by mission for AFAS while moving

Experiments/scenarios in the DIS virtual environment could determine operational and technical tradeoffs offered by alternative manning levels, task loading, crew station configurations, and soldier-machine interfaces (SMIs). The primary area under examination will be crew response time under varying mission loads, however, there may be some correlations between crew size and system survivability, threat entity kills, fratricides, and number of missions fired by type. Installation of an actual C^3 Subsystem prototype in the AFAS simulator provides the opportunity to experiment with various hardware and software design architectures and crew configurations to determine the best fit to meet overall response times for any specified crew level.

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with prototype C^3 Subsystem complete with BCC, radios, modems, crew stations, crew displays, supporting software, and access to M712 Copperhead rounds in the ammunition storage area.
- One FARV simulator and crew or FARV SAFOR and SAFOR controller to support resupply operations. Fire Support Automated Test System (FSATS) could be upgraded to support digital messaging from a SAFOR FARV to an AFAS manned simulator during docking operations to coordinate and control ammunition and fuel transfer.
- One LRP SAFOR and LRP controller to support FARV upload/download operations.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield. FSATS could be employed as an alternative to generate calls for fire that drive a highly controlled scenario.
- One AFATDS POC computer operator to process the observer's call for fire. Another alternative is to upgrade FSATS POC node so that the FSATS POC may interface with AFAS and FARV. Testers could then embed the scenario in FSATS and allow the AFAS and FARV crews to interact with FSATS message traffic generated by the POC or observer nodes as appropriate.
- Threat SAFOR operations order and controller to execute order.
- Friendly force operations order with fire support coordination measures and battlefield geometry and controller to execute order.

Subject of Experimentation/Testing. FARV Crew Size and Military Occupational Specialtly (MOS)

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Personnel. The system shall be operated by a three man crew. It is expected that each crew member will possess a 13B MOS.	FARV simulator equipped with C3 Subsystem complete with radios, modem, and crew station displays and decison aids.	Number of missions and projectiles fired	**Number of fire missions fired**	
			Mission Fired Reports (MFR) transmitted by AFAS to POC	Event Report PDUs to designate each MFR transmitted
			Projectile type and number fired	Fire and Detonation PDUs
		Number of threat and friendly losses	**Vehicles sustaining combat damage**	
			Number of AFASs	Entity State PDU
			Number of FARVs	Entity State PDU
			Number and type of threat entities	Entity State PDU
		Number of AFAS resupply requests sent directly to the FARV and time to complete resupply.	**Time**	
			Time resupply requests acknowledged by FARV	Signal PDU
			Time resupply completed by FARV	Event Report PDU
			Number of AFAS resupply requests sent directly to FARV	
			Message type = resupply	Signal PDU
			Message sender	Transmitter PDU
			Message receiver	Receiver PDU
		Number of AFAS resupply requests sent to the POC and time to complete resupply.	Time acknowledged	Signal PDU
			Time resupply completed	Event Report PDU
			Number of AFAS resupply requests sent to POC	
			Message type = resupply	Signal PDU
			Message sender	Transmitter PDU
			Message receiver	Receiver PDU
			Time received and acknowledged	Signal PDU
			Time resupply completed	Event Report PDU

Subject of Experimentation/Testing. FARV Crew Size

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Reduced Crew. The system shall provide the capability for conducting its primary functions (resupply, move, communicate, and survive) with two crew members for up to 4 hours with no degradation in performance.	FARV simulator equipped with C3 Subsystem complete with radios, modem, and crew station displays and decison aids.	Number of missions and projectiles fired	**Number of fire missions fired**	
			Mission Fired Reports (MFR) transmitted by AFAS to POC	Event Report PDUs to designate each MFR transmitted
			Projectile type and number fired	Fire and Detonation PDUs
		Number of threat and friendly losses	**Vehicles sustaining combat damage**	
			Number of AFASs	Entity State PDU
			Number of FARVs	Entity State PDU
			Number and type of threat entities	Entity State PDU
		Number of AFAS resupply requests sent directly to the FARV and time to complete resupply.	**Time**	
			Time resupply requests acknowledged by FARV	Signal PDU
			Time resupply completed by FARV	Event Report PDU
			Time crew reduced from 3 to 2 crew members	X (Manual Entry)
			Number of AFAS resupply requests sent directly to FARV	
			Message type = resupply	Signal PDU
			Message sender	Transmitter PDU
		Number of AFAS resupply requests sent to the POC and time to complete resupply.	Message receiver	Receiver PDU
			Time acknowledged	Signal PDU
			Time resupply completed	Event Report PDU
			Number of AFAS resupply requests sent to POC	
			Message type = resupply	Signal PDU
			Message sender	Transmitter PDU
			Message receiver	Receiver PDU
			Time received and acknowledged	Signal PDU
			Time resupply completed	Event Report PDU

Subject of Experimentation/Testing. FARV Crew Size

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** DIS experimentation and testing appears feasible to assess the operational and technical tradeoffs involved in varying AFAS crew size. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to changes in crew size:

- Number and type of missions fired (i.e., standard, MRSI, Copperhead)
- Number of projectiles fired by type
- Number of AFASs and FARVs sustaining combat damage
- Resupply response time by resupply request by control mode (centralized or decentralized)

Experiments/scenarios in the DIS virtual environment could determine operational and technical tradeoffs offered by alternative manning levels, task loading, crew station configurations, and soldier-machine interfaces (SMIs). The primary area under examination will be crew response time under varying mission loads, however, there may be some correlations between crew size and system survivability and the number of projectiles and missions fired. Installation of an actual C^3 Subsystem prototype in the FARV simulator provides the opportunity to experiment with various system and software design architectures and crew configurations to determine the best fit to meet overall resupply response times for any specified crew level.

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with prototype C^3 Subsystem complete with BCC, radios, modems, crew stations, crew displays, supporting software, and access to M712 Copperhead rounds in the ammunition storage area.
- One FARV simulator and crew or FARV SAFOR and SAFOR controller to support resupply operations. Fire Support Automated Test System (FSATS) could be upgraded to support digital messaging from a SAFOR FARV to an AFAS manned simulator during docking operations to coordinate and control ammunition and fuel transfer.
- One LRP SAFOR and LRP controller to support FARV upload/download operations.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield. FSATS could be employed as an alternative to generate calls for fire that drive a highly controlled scenario.
- One AFATDS POC computer operator to process the observer's call for fire. Another alternative is to upgrade FSATS POC node so that the FSATS POC may interface with AFAS and FARV. Testers could then embed the scenario in FSATS and allow the AFAS and FARV crews to interact with FSATS message traffic generated by the POC or observer nodes as appropriate.
- Threat SAFOR operations order and controller to execute order.
- Friendly force operations order with fire support coordination measures and battlefield geometry and controller to execute order.

Subject of Experimentation/Testing: AFAS Crew MOPP Levels
1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
MOPP 4 Conditions. The system shall be operable and maintainable by crew members while wearing Mission Oriented Protective Posture (MOPP) 4 and other environmental protective clothing. The use of MOPP 4 clothing by the crew indicates either a requirement for operations outside the crew compartment, or that the NBC defensive system that protects the crew is not operational. This NBC defensive system detects presence of all known NBC contaminants and includes NBC detection, warning, filtration and environmental conditioning systems.	Virtual or Live	Time Accuracy	All data elements related to crew operations and system maintenance time and accuracy for all experiment variable listed in this study, e.g., crew times to conduct a Copperhead mission, with and without MOPP 4 clothing on.	All DIS PDUs defined for other crew operations and system maintenance experiment variables elsewhere in this study. No new DIS PDUs must be defined.
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation and maintenance of the AFAS, with and without MOPP 4 clothing on. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	Time Command execution speeds Accuracy Correct operational sequencing	 X X

Subject of Experimentation/Testing: AFAS Crew MOPP Levels

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Planners can derive both technical and operational data about performance degradation caused by wearing a cumbersome, uncomfortable and stress producing set of protective gear. Across an extended period of operations, the wearing of MOPP 4 gear will degrade mental alertness and induce physical fatigue and discomfort, thereby raising stress levels. The combined effect should be sharply defined for all data elements associated with crew operations and maintenance defined for every other experiment variable in this study. The AFAS specification does not address any MOPP level other than MOPP 4, which involves the wearing of the full suit, properly sealed, with gloves and protective mask--the only condition that seriously impairs crew performance.

3. **Required Resources.** DIS PDUs that capture crew performance degradation in the conduct of both operational and technical tasks listed for all other experiment variables in this study.

Subject of Experimentation/Testing: FARV Crew MOPP Levels
1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
MOPP 4 Conditions. The system shall be operable and maintainable by crew members while wearing Mission Oriented Protective Posture (MOPP) 4 and other environmental protective clothing. The use of MOPP 4 clothing by the crew indicates either a requirement for operations outside the crew compartment, or that the NBC defensive system that protects the crew is not operational. This NBC defensive system detects presence of all known NBC contaminants and includes NBC detection, warning, filtration and environmental conditioning systems.	Virtual or Live	Time Accuracy	All data elements related to crew operations and system maintenance time and accuracy for all experiment variable listed in this study, e.g., crew times to conduct a Copperhead mission, with and without MOPP 4 clothing on.	All DIS PDUs defined for other crew operations and system maintenance experiment variables elsewhere in this study. No new DIS PDUs must be defined.
Training. Crew training level can be evaluated by tracking individual speed and accuracy in executing the commands and other functions associated with proper operation and maintenance of the FARV, with and without MOPP 4 clothing on. Accuracy is a function of executing the commands in the proper sequence.	Virtual or Live	Time Accuracy	**Time** Command execution speeds **Accuracy** Correct operational sequencing	 X X

Subject of Experimentation/Testing: FARV Crew MOPP Levels

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** Planners can derive both technical and operational data about performance degradation caused by wearing a cumbersome, uncomfortable and stress producing set of protective gear. Across an extended period of operations, the wearing of MOPP 4 gear will degrade mental alertness and induce physical fatigue and discomfort, thereby raising stress levels. The combined effect should be sharply defined for all data elements associated with crew operations and maintenance defined for every other experiment variable in this study. The FARV specification does not address any MOPP level other than MOPP 4, which involves the wearing of the full suit, properly sealed, with gloves and protective mask--the only condition that seriously impairs crew performance.

3. **Required Resources.** DIS PDUs that capture crew performance degradation in the conduct of both operational and technical tasks listed for all other experiment variables in this study.

Subject of Experimentation/Testing: AFAS Crew Positions

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Positions	SIL, Virtual	Can crew members perform their assigned tasks (TBD) within the specified time limits from their assigned crew positions.	Under normal operating conditions: Time required task initiated. Time required task completed. Specified time to complete task. Under degraded operating conditions: Time required task initiated. Time required task completed. Specified time to complete task.	X(1).
Intervisibility	SIL, Virtual	Is intervisibility required for safe operation of the vehicle and performance of tasks and missions.		X(1).
Between Crew Members	SIL, Virtual	Does having face-to-face intravisibility between crew members enhance mission accomplishment or does not having face-to-face intravisibility degrade mission accomplishment.	Time tasks (TBD) requiring crew coordination begin. Time tasks requiring crew coordination end. Increase or decrease in efficiency due to crew intervisibility	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
All Crew members have face-to-face capability	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with face to face capabilities.	What conditions require full face to face capability. Intercom working and not. NBC environment and Normal environment. How is crew coordination effected. Time to accomplish TBD tasks with face to face visibility capability. Time to accomplish tasks without face to face capability. Time to accomplish tasks without intercom and with face to face capability. Time to accomplish tasks without intercom and without face to face capability.	X(1).
Partial Body Visibility	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with partial visibility between crew members. Determine casualty monitoring capabilities.	What conditions allow partial or no visibility. Intercom working or not. NBC environment and normal environment. How is crew coordination effected. Time to accomplish TBD tasks with face to face visibility capability. Time to accomplish tasks without face to face capability. Time to accomplish tasks without intercom and with face to face capability. Time to accomplish tasks without intercom and without face to face capability.	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Between Crew and Weapon Stations	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with visibility between crew members and weapon stations. What conditions require visibility, how often do the conditions arise, etc.	Determine time to diagnose equipment malfunctions with direct visibility into weapons compartment and without direct view into weapons compartment. Determine time to detect dangerous situations and malfunctions with direct visibility into weapons compartment and without direct view into weapons compartment.	X(1).
Intravisibility Between docked/docking vehicles	Virtual	Direct sight lines from crew stations to the other vehicle.	Direct view or remote. Are mirrors and lenses sufficient? Is TV sufficient or better. Time to dock with intravisibility. Time to dock without intravisibility.	X(1).
Intravisibility Into Vehicle Compartments.	SIL, Simulator, Virtual	Direct sight lines from all crew stations to the vehicle compartments.	Direct view or remote. Are mirrors and lenses sufficient? Is TV sufficient or better.	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Intravisibility Between paired howitzers.	Virtual	Direct sight lines from crew stations to the other vehicle.	Direct view or remote. Are mirrors and lenses sufficient? Is TV sufficient or better. Ease of communication between howitzers. Ease of maintaining situational awareness/orientation between howitzers. Time to lay mission with intravisibility. Time to lay mission without intravisibilty.	X(1).
Ergress Options Two or more egress options.	SIL, Simulator	Did crew get out of the vehicle within TBD seconds.	Experiment with different combinations of exits and different emergency egress situations. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Egress Options Side Doors	SIL, Simulator	Can crew members in the crew compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Sufficient under all/most combat situations. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	X(1).
Ergress Options Top Hatch	SIL, Simulator	Can crew members in the crew compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Immersion in water? How many hatches? Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Ergress Options Bottom Hatch	SIL, Simulator	Can crew members in the crew compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Added safety during post incident period when vehicle is not erect or other exits not suitable. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	X(1).
Ergress Options Ammunition/Gun Compartment	SIL, Simulator	Can crew members in the primary weapons and ammunition compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Use as emergency exit or normal access during manual rearm operations. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress.	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Ergress Options Front Windows	SIL, Simulator	Can the crew get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Examine as a possible emergency exit. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	X(1).
Crew Access Access to stored munitions.	SIL, Simulator	Can the crew gain access to the stored munitions within TBD seconds? Can each crew member access the stored munitions while the other crew members perform their primary tasks.	Examine possible locations and methods of use. Examine possible secondary uses. Time crew determined necessity to access munitions. Time crew began to access munitions. Time crew accessed munitions. Time crew began to move munitions.	X(1).

Subject of Experimentation/Testing: AFAS Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Access Access to the Primary Weapons Station	SIL, Virtual	Can the crew gain access to the stored munitions within TBD seconds? Can each crew member access, aim and fire the self defense weapon while the other crew members perform their primary tasks.	Examine possible locations and methods of use. Examine possible secondary uses. Time crew determined necessity to access weapon Time crew began to access weapon. Time crew accessed weapon. Time ready to fire. Crew safety during access to primary weapons stations.	X(1).
Crew Access Access to the Self Defense Weapons Station	SIL, Virtual	Can each crew member access, aim and fire the self defense weapon while the other crew members perform their primary tasks.	Examine possible locations and methods of use. Time crew determined necessity to access weapon. Time crew began to access weapon. Time crew accessed weapon. Time ready to fire.	X(1).
Crew Access Access to Secondary Armament Ammunition	SIL, Virtual	Time crew determined necessity to access weapon. Can each crew member access, aim and fire the self defense weapon while the other crew members perform their primary tasks.	Examine possible locations and methods of use. Examine possible secondary uses. Time crew determined necessity to access weapon. Time crew began to access weapon. Time crew actually accessed weapon. Time ready to fire.	X(1).

X(1). Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.

Subject of Experimentation/Testing: AFAS Crew Positions

2. Technical and Operational Benefits of Experimentation with Crew Positions in DIS Virtual Environment.

2.1 Stated specifications.

The crew must be able to efficiently perform specified duties from his crew position.

The crew must be able to see each other while in their crew positions, in the crew cab.

Intravisibility between the AFAS and FARV during refueling operations.

Intravisibility between crew members at their crew positions and vehicle compartments.

Each crew member must have access to at least two egress options.

Crew members must have easy access to their alternate stations, i.e. secondary weapon, primary weapon loading area and storage areas.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. Is face-to-face visibility capability required? What degree of intervisibility is required when crew members are out of their seats performing secondary tasks like loading Copperhead rounds or clearing jammed equipment. How is crew efficiency effected. How is overall system safety effected.

2.3 Sample Experiment. There are several efficiency and safety related aspects that can be evaluated while operating in a DIS environment. DIS can only provide an environment for evaluating relative crew efficiency with and without visibility under operational conditions. Data needed to indirectly evaluate crew efficiency will be generated as the crew responds to the scenario. One critical aspect to evaluate is the degree to which intervisibility enhances safety, crew coordination, and operations with a contaminated crew cab.

several needed

1. Set up a standard combat scenario. From previous tests, establish baseline times to accomplish standard tasks such as rearming, firing, repositioning, etc. Run the scenario times while varying the degrees of visibility between the crew members inside the crew cab, the ammunition storage racks and loading compartment. Measure any the times to accomplish the standard tasks and compare them to the base line.

2. Run the same scenarios, only with a contaminated crew cab so that all crew members are in MOPP-4, and have one crew member simulate suffering from NBC poisoning, and see how long it takes the other crew members to discover the poisoned crew member.

3. Run the same scenarios given above. This time the crew must perform their duties without the use of the intercom system, where alternate forms of communication, including visual signals, are likely to be used. Evaluate the impact on mission effectiveness of varying combinations of lack of visibility and intercom communication capability.

3. Required Resources.

To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator's crew cab.
- One fully equipped AFAS simulator with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One observer/ SAFOR to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update AFAS information base on fire support coordination measures and battlefield geometry, meteorological data, and preplanned targets.

Subject of Experimentation/Testing: AFAS Crew Positions

- One FARV SAFOR to support resupplying operations.
- One AFAS SAFOR to support senior to subordinate AFAS operations.
- Threat SAFOR operations order.
- Threat SAFOR to execute the order.
- Friendly force operations order with fire support coordination measures and battlefield geometry.
- Friendly SAFOR to execute the order.

4. **Emulators Required.** The following models or emulations will be needed to support the AFAS simulator.

Subject of Experimentation/Testing: FARV Crew Positions

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Positions		Can crew members perform their assigned tasks (TBD) within the specified time limits from their positions.	Under normal operating conditions:	
			Time required task initiated.	Event report PDU
			Time required task completed.	Event report PDU
			Specified time to complete task.	X
			Under degraded operating conditions:	
			Time required task initiated.	Event report PDU
			Time required task completed.	Event report PDU
			Specified time to complete task.	X
Intervisibility		Is intervisibility required for safe operation of the vehicle and performance of tasks and missions.		
Between Individual Crew Members		Does having face-to-face intravisibility between crew members enhance mission accomplish-ment or does not having face-to-face intravisibility degrade mission accomplish-ment.	Time tasks (TBD) requiring crew coordination begin.	Event report PDU
			Time tasks requiring crew coordination end.	Event report PDU
			Increase or decrease in efficiency due to crew inter-visibility	

Subject of Experimentation/Testing: FARV Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
All Crew members have face to face capability	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with face to face capabilities. Can each crew member see all other crew member's face from his crew position.	What conditions require full face to face capability. Intercom working and not. NBC environment and normal environment. How is crew coordination effected. Time to accomplish TBD tasks with face to face visibility capability. Time to accomplish TBD tasks without face to face capability. Time to accomplish TBD tasks without intercom and with face to face capability. Time to accomplish tasks without intercom and without face to face capability.	 Entity state PDU $X_{(1)}$. $X_{(1)}$. $X_{(1)}$. $X_{(1)}$. $X_{(1)}$.
Partial Body Visibility	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with partial visibility between crew members. Determine casualty monitoring capabilities.	What conditions allow partial or no visibility. Intercom working or not. NBC environment and normal environment. How is crew coordination effected. Time to accomplish TBD tasks with face to face visibility capability. Time to accomplish tasks without face to face capability. Time to accomplish tasks without intercom and with face to face capability. Time to accomplish tasks without intercom and without face to face capability.	 Entity state PDU $X_{(1)}$. $X_{(1)}$. $X_{(1)}$. $X_{(1)}$. $X_{(1)}$.

Subject of Experimentation/Testing: FARV Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Between Crew and Storage, Handling Equipment	SIL, Virtual	Can each crew member see/visually monitor the materials handling equipment from his crew position.	What conditions require visibility, how often do the conditions arise, etc.	$X_{(1)}$.
			Determine time to diagnose equipment malfunctions with direct visibility into weapons compartment and without direct view into weapons compartment.	$X_{(1)}$.
			Determine time to detect dangerous situations and malfunctions with direct visibility into weapons compartment and without direct view into weapons compartment.	$X_{(1)}$.
Intravisibility Between docked/docking vehicles	Virtual	Direct sight lines from crew stations to the other vehicle.	Direct view or remote.	
			Are mirrors and lenses sufficient?	$X_{(1)}$.
			Is TV sufficient or better.	$X_{(1)}$.
			Time to dock with intravisibility.	Event report PDU
			Time to dock without intravisibility.	Event report PDU
Intravisibility Into Vehicle Compartments.	SIL, Virtual, Simulator	Can each crew member view the vehicle compartments from his crew position.	Direct view or remote.	$X_{(1)}$.
			Mirrors and lenses sufficient? TV sufficient or better.	$X_{(1)}$.
Ergress Options Two or more egress options.	SIL, Simulator	Each crew member must have at least two different exits/exit routes to get out of the vehicle in case of emergency from each crew position and work area.	Experiment with different combinations of exits and different emergency egress situations.	
			Time crew determines to egress.	Event response PDU
			Time egress started.	Event report PDU
			Time egress finished.	Event report PDU
			Time for each person to egress.	$X_{(1)}$.
			Elapsed time for all crew members to egress.	$X_{(1)}$.
			All crew members egress the vehicle without injury or damage to the vehicle.	$X_{(1)}$.

Subject of Experimentation/Testing: FARV Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Egress Options Side Doors	SIL, Simulator	Can crew members in the crew compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Sufficient under all/most combat situations. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	$X_{(1)}$. Event report PDU Event report PDU Event report PDU $X_{(1)}$. $X_{(1)}$. $X_{(1)}$.
Top Hatch	SIL, Simulator	Can crew members in the crew compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Added safety during immersion in water? How many hatches? Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress.	 Event report PDU Event report PDU Event report PDU $X_{(1)}$.

Subject of Experimentation/Testing: FARV Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Egress Options Bottom Hatch	SIL, Simulator	Can crew members in the crew compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Added safety during post incident period when vehicle is not erect or other exits not suitable Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress. All crew members egress the vehicle without injury or damage to the vehicle.	 Event report PDU Event report PDU Event report PDU $X_{(1)}$. $X_{(1)}$. $X_{(1)}$. / Entity state PDU
Egress Options Ammunition/Storage Compartment	SIL, Simulator	Can crew members in the ammunition storage compartment get out of the vehicle within TBD seconds. Can all crew members egress the vehicle without injury or unnecessary damage to the vehicle.	Use as emergency exit or normal access during manual rearm operations. Time crew determines to egress. Time egress started. Time egress finished. Time for each person to egress. Elapsed time for all crew members to egress.	 Event report PDU Event report PDU Event report PDU $X_{(1)}$. Entity state PDU

Subject of Experimentation/Testing: FARV Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Ergress Options Front Windows	SIL, Simulator	Can the crew get out of the vehicle within TBD seconds.	Examine front windows as a possible emergency exit.	
			Time crew determines to egress.	Event report PDU
			Time egress started.	Event report PDU
			Time egress finished.	Event report PDU
			Time for each person to egress.	$X_{(1)}$.
			Elapsed time for all crew members to egress.	$X_{(1)}$.
			All crew members egress the vehicle without injury or damage to the vehicle.	$X_{(1)}$. /Entity state PDU
Crew Access Access to stored munitions.	SIL, Simulator	Can each crew member access the stored munitions while the other crew members perform their primary tasks.	Examine possible locations and methods of use.	
			Time crew determined necessity to access munitions.	Event report PDU
			Time crew began to access munitions.	Event report PDU
			Time crew accessed munitions.	Event report PDU
			Time crew began to move munitions.	Entity state PDU
Crew Access Access to the Self Defense Weapons Station	SIL, Simulator	Can each crew [illegible]pon while the other crew members perform their primary tasks.	[illegible]	
			Time crew determined necessity to access weapon.	Event report PDU
			Time crew began to access weapon.	Event report PDU
			Time crew accessed weapon.	Event report PDU
			Time ready to fire.	Entity state PDU

Subject of Experimentation/Testing: FARV Crew Positions

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Access Access to Secondary Armament Ammunition	SIL, Virtual	Time crew determined necessity to access weapon. Can each crew member access, aim and fire the self defense weapon while the other crew members perform their primary tasks.	Examine possible locations and methods of use. Examine possible secondary uses. Time crew determi[illegible]sity to access weapon. Time crew begar [illegible]apon. Time crew actually [illegible]d weapon. Time ready to fire.	 Event report PDU Event report PDU Event report PDU Entity state PDU

X(1). **Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.**

Subject of Experimentation/Testing: FARV Crew Positions

2. Technical and Operational Benefits of Experimentation with Crew Intervisibility and Intravisibility in DIS Virtual Environment.

2.1 Stated specifications.

- The crew must be able to efficiently perform specified duties from his crew position.
- The crew must be able to see each other while in their crew positions, in the crew cab.
- Intravisibility between the AFAS and FARV during refueling operations.
- Intravisibility between crew members at their crew positions and vehicle compartments.
- Each crew member must have access to at least two egress options.
- Crew members must have easy access to their alternate stations, i.e. secondary weapon, primary weapon loading area and storage areas.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. Is face-to-face visibility capability required? What degree of intervisibility is required when crew members are out of their seats performing secondary tasks like loading Copperhead rounds or clearing jammed equipment. How is crew efficiency effected. How is overall system safety effected.

2.3 Sample Experiment. There are several efficiency and safety related aspects that can be evaluated while operating in a DIS environment. DIS can only provide an environment for evaluating relative crew efficiency with and without visibility under operational conditions. Data needed to indirectly evaluate crew efficiency will be generated as the crew responds to the scenario. One critical aspect to evaluate is the degree to which intervisibility enhances safety, crew coordination, and operations with a contaminated crew cab.

1. Set up a standard combat scenario. From previous tests, establish baseline times to accomplish standard tasks such as rearming, firing, repositioning, etc. Run the scenario several times while varying the degrees of visibility between the crew members inside the crew cab, the ammunition storage racks and loading compartment. Measure any the times needed to accomplish the standard tasks and compare them to the base line.

2. Run the same scenarios, only with a contaminated crew cab so that all crew members are in MOPP-4, and have one crew member simulate suffering from NBC poisoning, and see how long it takes the other crew members to discover the poisoned crew member.

3. Run the same scenarios given above. This time the crew must perform their duties without the use of the intercom system, where alternate forms of communication, including visual signals, are likely to be used. Evaluate the impact on mission effectiveness of varying combinations of lack of visibility and intercom communication capability.

3. Required Resources. To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator's crew cab.
- One fully equipped AFAS simulator with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One observer/ SAFOR to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update AFAS information base on fire support coordination measures and battlefield geometry, meteorological data, and preplanned targets.
- One FARV SAFOR to support resupplying operations.
- One AFAS SAFOR to support senior to subordinate AFAS operations.

Subject of Experimentation/Testing: FARV Crew Positions

- Threat SAFOR operations order.
- Threat SAFOR to execute the order.
- Friendly force operations order with fire support coordination measures and battlefield geometry.
- Friendly SAFOR to execute the order.

4. **Emulators Required.** The following models or emulations will be needed to support the AFAS simulator.

Subject of Experimentation/Testing. AFAS Environment.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Environment				
Normal Operations	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with full system capabilities.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine baseline time required to accomplish task(s).	X(1).
NBC Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1).
Arctic Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1).

Subject of Experimentation/Testing. AFAS Environment

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Tropical Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling is inoperative.	X(1).
Desert Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1).
Long Term Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1).

Subject of Experimentation/Testing. AFAS Environment

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Abnormal Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads with degraded environmental and life support systems. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier.	X(1).
Manual Ammunition Handling Capability	SIL, Virtual	Can the crew manually select and load a round.	Different equipment configurations, techniques, environmental conditions, etc. Time reload started. Time reload ended.	X(1).
Crew Access To Ammunition Storage	SIL, Virtual	Can the crew have easy access to ammunition storage and loading area.	Different equipment configurations, techniques, environmental conditions, etc. Time Copperhead Mission Arrived. Time Crew member left crew position. Time Crew member begins preparing the round to fire.	X(1).
Internal room to Handle All Ammunition and Propellant	SIL, Virtual	Can the crew manually select and load a round without performing awkward movements or face an high risk of injury.	Different equipment configurations, techniques, environmental conditions, etc. Time manual reload starts. Time manual reload ends. Number of combined bending and lifting motions. Number of combined lifting and twisting motions involved.	X(1).

X(1). **Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.**

Subject of Experimentation/Testing. AFAS Environment

2. Technical and Operational Benefits of Experimentation with Crew Environments in DIS Virtual Environment.

2.1 Stated Specifications. Crew must be able to perform continuous operations for a minimum of 48 hours without leaving the crew cab. An implied specification is that the crew environm[...]n nywhere in the world. The test will try to determine the effect of crew cab environment/life support systems failures on crew effectiveness over the 48 hour evaluation period. NBC protection, p[...]i ssure system, is not included in the 48 hour specification, so that to completely test the specification, at least one series of tests will require that the crew wear NBC gear. The DIS can only provide [...] er a long period of time under operational conditions. Data needed to indirectly evaluate crew efficiency will be generated as the crew responds to the scenario.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. N/A.

2.3 Sample Experiment. Set up a standard 48 hour scenario. From previous tests, establish some baseline times to accomplish standard tasks such as rearming, firing, repositioning, etc. R[...] humidity inside the crew cab. Measure any the times needed to accomplish the standard tasks and compare them to the base line.

3. Required Resources.

To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator's crew cab.
- One fully equipped AFAS simulator with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One observer/ SAFOR to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update AFAS info d geometry, meteorological data, and preplanned targets.
- One AFAS SAFOR to support senior to subordinate AFAS operations.
- Threat SAFOR operations order.
- Threat SAFOR to execute the order.
- *Friendly force operations order* with fire support coordination measures and battlefield geometry.
- Friendly SAFOR to execute the order.

4. Emulators Required. The following models or emulations will be needed to support the AFAS simulator.

Subject of Experimentation/Testing. FARV Environment.

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Environment Normal Operations	SIL, Virtual	Establish base line times for individual and crew tasks at one hour intervals over a period of 48 hours with full system capabilities.	Determine crew task loading, crew coordination requirements, and physical effort expended under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine baseline time required to accomplish task(s).	X(1). Event report PDU Event report PDU X(1).
Crew Environment NBC Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1). Event report PDU Event report PDU X(1). X(1).
Crew Environment Arctic Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1). Event report PDU Event report PDU X(1). X(1).

Subject of Experimentation/Testing. FARV Environment.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Environment Tropical Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier.	$X_{(1)}$. Event report PDU Event report PDU $X_{(1)}$.
Crew Environment Desert Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	$X_{(1)}$. Event report PDU Event report PDU $X_{(1)}$. $X_{(1)}$.
Crew Environment Long Term Operations	SIL, Virtual	Quantify fatigue factors. Measure times to complete baseline tasks at one hour intervals over 96 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	$X_{(1)}$. Event report PDU Event report PDU $X_{(1)}$. $X_{(1)}$.

Subject of Experimentation/Testing. FARV Environment.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Crew Environment Abnormal Operations	SIL, Virtual	Measure times to complete baseline tasks at one hour intervals over 48 hour period. Determine the difference from Normal Operations baseline tasks.	Determine crew loading, crew coordination requirements, under varying workloads. Time task(s) (TBD) began. Time task(s) ended. Determine difference between time required for accomplishing task(s) compared to baseline time required to accomplish task(s) determined earlier. Determine difference in crew performance when crew compartment cooling/heating is inoperative.	X(1). Event report PDU Event report PDU X(1). X(1).
Manual Ammunition Transfer Capability	SIL, Virtual	Can the crew transfer TBD rounds of ammunition in TBD minutes.	Different equipment configurations, techniques, environmental conditions, etc. Time reload started. Time reload ended.	X(1). Event report PDU Event report PDU
Crew Access To Ammunition Storage	SIL, Virtual	Can the crew get into the ammunition storage area without disrupting other mission operations within TBD seconds.	Different equipment configurations, techniques, environmental conditions, etc. Time Copperhead Mission Arrived. Time Crew member left crew position. Time Crew member begins preparing the round to fire.	X(1). Event report PDU Event report PDU X(1).
Internal room to handle all ammunition and propellant	SIL, Virtual	Can the crew safely prepare and load special munitions without risk of injury.	Different equipment configurations, techniques, environmental conditions, etc. Time manual reload starts. Time manual reload ends. Times crew must reposition the round without support. Amount of bending and twisting the crew must perform while carrying or holding the round.	X(1). Event report PDU Event report PDU X(1). X(1).

X(1). Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.
2. Technical and Operational Benefits of Experimentation with Crew Environments in DIS Virtual Environment.

Subject of Experimentation/Testing. FARV Environment.

2.1 Stated specifications. Crew must be able to perform continuous operations for a minimum of 48 hours without leaving the crew cab. An implied specification is that the crew environment must be controlled so that continuous operations are possible anywhere in the world. The test will try to determine the effect of crew cab environment/life support systems failures on crew effectiveness over the 48 hour evaluation period. NBC protection, provided by a filtration system and crew compartment over-pressure system, is not included in the 48 hour specification, so that to completely test the specification, at least one series of tests will require that the crew wear NBC gear. The DIS can only provide an environment for evaluating the crew efficiency over a long period of time under operational conditions. Data needed to indirectly evaluate crew efficiency will be generated as the crew responds to the scenario.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. N/A.

2.3 Sample Experiment. Set up a standard 48 hour scenario. From previous tests, establish some baseline times to accomplish standard tasks such as rearming, firing, repositioning, etc. Run the scenario several times while varying the temperature and humidity inside the crew cab. Measure any the times needed to accomplish the standard tasks and compare them to the base line.

3. Required Resources.

To support experimentation and testing in the areas identified above the following resources are required:

- One FARV crew to man an FARV simulator's crew cab.
- One fully equipped FARV simulator with radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- One AFAS crew to man an AFAS simulator's crew cab.
- One fully equipped AFAS simulator with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
- *One observer/ SAFOR to acquire and submit calls for fire to the AFAS to engage opposition force targets* on the virtual battlefield.
- One fire direction computer operator
- One AFATDS POC computer to process the resupply requests and manage FARV inventory during centralized AFAS operations, automatically relay resupply requests during decentralized operations, and update AFAS and FARV information base on ammunition requests and inventory on hand.
- One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update AFAS information base on fire support coordination measures and battlefield geometry, meteorological data, and preplanned targets.
- One AFAS SAFOR to support senior to subordinate AFAS operations.
- Threat SAFOR operations order.
- Threat SAFOR to execute the order.
- Friendly force operations order with fire support coordination measures and battlefield geometry.
- Friendly SAFOR to execute the order.

Subject of Experimentation/Testing. AFAS and FARV System Safety

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Hazard Alerts. The system shall provide both audible and visible warnings to alert the crew to internal and external hazardous situations, e.g., fire, NBC contamination, LP spills, and vehicle backing up. These warnings shall not interrupt mission critical functions or create unsafe situations in tactical environments.	Live testing AFAS and FARV simulators with installed C^3 Subsystem	System survivability by type and number of hazard alerts received by the crew.	**Number of operational AFASs and FARVs at end of experiment by type of hazard alert**	
			ID of each operational vehicle	Entity State PDU
			Types of hazard alerts activated by time and operational vehicle ID	Event Report PDU
		Detection and warning of violations of fire support coordination measures and friendly battlefield geometry in correlaltion with fratricides	**Number of AFASs and FARVs sustaining combat damage and/or requiring unscheduled maintenance at end of experiment by type of hazard alert**	
			ID of each disabled vehicle	Entity State PDU
			Nature of combat damage or maintenance deficiency	Entity State & Service Request PDUs
			Types of warnings activated by time and disabled vehicle ID	Event Report PDU
			Identification of crew warning enunciators activated	Event Report PDU
			Target number violating control measures	Event Report PDU
			Location	
			Location of fire support coordination measure and battlefield geometry (maneuver control measure/unit location)	Recommend use of Event Report PDU to report violations of control measures based on an examination of the data elements detailed under Location.
			Location of target in call for fire	
			Location of AFAS howitzer	
			Location of projectile trajectory (as plotted on x,y,z	
			Number of Fratricides	Fire PDU Detonation PDU Entity State PDU
Software Safety. The system shall not allow correct or incorrect entries by the crew to cause a hazardous situation.	SIL and live testing			
Emergency Override. The system shall allow for the crew to manually override automatic responses to equipment malfunction/out-of-limit operation in the event of an emergency.	Live testing			

Subject of Experimentation/Testing. AFAS and FARV System Safety

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Finishing. Finished items shall have no raw, sharp, or rough edges. Edges and corners that present a personnel safety hazard or potential damage to the equipment shall be suitably protected, rounded, or chamfered.	Live testing			
Entrapment. Safeguards shall be installed to prevent inadvertent contact with, or entrapment of, body parts or clothing in moving parts, hatches, or doors.	Live testing			
Non-Skid Surfaces. Non-skid surfaces and hand holds shall be provided in equipment mounting, traffic, and dismounting areas.	Live testing			
Crew Station Restraints. Interior surfaces of the crew station shall be padded or arranged to insure the crew members are protected in crash or rough terrain operations. Restraint systems are required in all crew positions.	Live testing			
Engine Throttle Shut-Down. The system shall have at least two independent controls capable of returning the throttle to idle position.	Live testing			
Training Safety. The system shall include safety features to prevent inadvertent live firings. The system shall indicate to the operator when the system is in a training mode.	Live testing System SIL			

Subject of Experimentation/Testing. AFAS and FARV System Safety

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Crew Warnings. The system shall provide warnings to the crew. These warnings shall not interrupt mission critical functions (shoot, move, communicate, or survive) unless the warning is of an unsafe or hazardous condition.	Live testing AFAS and FARV simulators with installed C^3 Subsystem	System survivability by type and number of hazard alerts received by the crew.	**Number of operational AFASs and FARVs at end of experiment by type of crew warning**	
			ID of each operational vehicle	Entity State PDU
			Types of hazard alerts activated by time and operational vehicle ID	Event Report PDU
		Detection and warning of violations of fire support coordination measures and friendly battlefield geometry in correlaltion with fratricides	**Number of AFASs and FARVs sustaining combat damage and/or requiring unscheduled maintenance at end of experiment by type of crew warning**	
			ID of each disabled vehicle	Entity State PDU
			Nature of combat damage or maintenance deficiency	Entity State & Service Request PDUs
			Types of warnings activated by time and disabled vehicle ID	Event Report PDU
			Identification of crew warning enunciators activated	Event Report PDU
			Target number violating control measures	Event Report PDU
			Location	
			Location of fire support coordination measure and battlefield geometry (maneuver control measure/unit location)	Recommend use of Event Report PDU to report violations of control measures based on an examination of the data elements detailed under **Location**.
			Location of target in call for fire	
			Location of AFAS howitzer	
			Location of projectile trajectory (as plotted on x,y,z	
			Number of Fratricides	Fire PDU
				Detonation PDU
				Entity State PDU

Subject of Experimentation/Testing. AFAS and FARV System Safety

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Lighting System. All controls and displays utilizing incandescent illumination and their nomenclature shall be illuminated with variable intensity light.	AFAS and FARV simulators with installed C^3 Subsystem	Lighting of controls and displays is mapped to crew performance of cognitive tasks.	**Time**	
			Time crew received requirement to execute a cognitive task (*i.e.*, plan a tactical movement)	Event Report PDU
			Time required for the crew to complete cognitive task (i.e., plan and store a primary and alternate route)	Event Report PDU
		Although live testing of the lighting system is the best test. Some form of lighting system is required in the simultor during closed-hatch operations, which can serve as a precursor for the development of the actual lighting system.	**Designation of lighting system supporting the experiment**	X (Manual Entry)

Subject of Experimentation/Testing. AFAS and FARV System Safety

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment.

2.1 Specifications supportable by DIS. Based on the results derived from the above matrix, DIS experimentation/testing appears feasible to assess the operational and technical tradeoffs in AFAS and FARV specifications addressing the following areas:

- Hazard alerts
- Crew warnings
- Crew cab lighting system

2.2 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications in paragraph 2.1. Analysts and testers can run the same experiment repeatedly altering hazard and crew warnings and crew cab lighting to determine operational and technical tradeoffs offered by alternative configurations. Installation of an actual C^3 Subsystem prototype in a FARV simulator provides the opportunity to experiment with various alerts, warnings, and lighting that produce optimum crew/force safety and crew efficiency. Placing AFAS and FARV simulators on a combined arms virtual battlefield permits evaluation of design changes that can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design changes in system safety:

- Number of fratricides resulting from the violation of fire support coordination measures and battlefield geometry based on C^3 Subsystem warnings provided.
- Number of AFASs and FARVs sustaining combat damage and unscheduled maintenance based on hazard alerts and crew warnings activated during the experiment
- Crew time to complete cognitive tasks based on various lighting system configurations.

3. Required Resources. *To support experimentation and testing in the areas identified above the following resources are required:*

- One AFAS crew to man an AFAS simulator
- One AFAS simulator complete with C^3 Subsystem with BCC, 2 radios, intercom modems, crew stations, crew displays, supporting software.
- One FARV simulator and crew to support resupply operations.
- One LRP SAFOR and LRP controller to support FARV upload/download operations.
- One AFAS SAFOR and SAFOR controller to support senior to subordinate AFAS operations. FSATS could be upgraded to support digital messaging from a SAFOR Subordinate AFAS to a Senior AFAS manned simulator to support senior/subordinate howitzer operations.
- One observer to acquire and submit calls for fire to engage opposition force targets on the virtual battlefield. FSATS could be employed as an alternative to generate calls for fire that drive a highly controlled scenario.
- One AFATDS POC computer operator to process the observer's call for fire. Another alternative is to upgrade FSATS POC node so that the FSATS POC may interface with AFAS and FARV. Testers could then embed the scenario in FSATS and allow the AFAS and FARV crews to interact with FSATS message traffic generated by the POC or observer nodes as appropriate.
- Threat SAFOR operations order and controller to execute order.
- Friendly force operations order with fire support coordination measures and battlefield geometry and controller to execute order.

Subject of Experimentation/Testing: AFAS Mobility .

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Vehicle Mobility				
AFAS Mobility Criteria Max Speeds 67 kph Sustained Speed Over Hard Surfaced Roads. 39 kph sustained speed cross country at a rolling resistance of 90 kg/tonne	Live Test, Virtual	Average Sustained Speed >= 67 kph. Average sustained cross country speed of 39 kph.	Time movements started. Time movements ended. Distance between check points or start and stop points. Times/Speeds between firing points. Type of suspension system employed Type of automotive system employed. Variables in the Automotive Subsystems.	Entity state PDU Entity state PDU Entity state PDU Event report PDU X(1) X(1) X(1)
AFAS Mobility Criteria Max Speeds Sustain 20 kph in Reverse Over Hard Surfaced Roads.	Live Test, Virtual	Average Sustained Speed >= 20 kph.	Time movements started. Time movements ended. Distance between start and stop points. Types of Motive Power used. Types of Rear Vision Devices used.	Entity state PDU Entity state PDU Entity state PDU Event report PDU Event report PDU
AFAS Mobility Criteria Max Speeds Maintain minimum tactical speeds on grades of 2% to 60% (as defined below). 2%——65.0 kph 30%——13.5 kph 5%——47.4 kph 40%——9.5 kph 10%——32.0 kph 50%——8.3 kph 15%——23.7 kph 60%——7.0 kph 20%——19.5 kph	Live Test, Virtual	Average sustained speed >= prescribed speeds on same slopes.	Time movements started. Time movements ended. Distance between start and stop points. Effects of Motive Power	Entity state PDU Entity state PDU Event report PDU Event report PDU

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Braking	Live Test, Virtual	Decelerate from maximum speed at an average rate of 5 m/s^2. at full combat weight. Side drift during stop not to exceed 2 meters per 15 meters of forward travel. Accomplish 25 consecutive stops at five minute intervals from 80% maximum speed at a rate of 3.3 m/s2 at full combat weight.	Time braking initiated. Speed at time braking initiated. Time vehicle stops. Direction traveling at time braking initiated. Direction traveling when vehicle stopped. Lateral drift distance. Time elapsed between full stops. Number of full stops.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU Entity state PDU Entity state PDU and Event report PDU. Entity state PDU Entity state PDU
AFAS Mobility Criteria Max Speeds Must keep up with the maneuver forces.	Live Test, Virtual	Average distance between maneuver force area of influence and AFAS area of influence >=1.	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between firing points, Distance from FLOT during a battle, at each response to call for fire point.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU Event report PDU
AFAS Mobility Criteria Max Speeds Sustain Max Speed on 25mm root mean square terrain	Live Test, Virtual	Average sustained speed = maximum XC speed.	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between firing points.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Max Speeds Sustain 64 kph over 38mm root mean square profile terrain	Live Test, Virtual	Average Sustained Speed >= 64 kph.	Time movements started.	Entity state PDU
			Time movements ended.	Entity state PDU
			Distance between start and stop points.	Entity state PDU
			Times/Speeds between firing points.	Entity state PDU
			Type of suspension system employed	X
			Type of automotive system employed.	X
AFAS Mobility Criteria Max Speeds Sustain 40 kph over 51mm root mean square profile terrain	Live Test, Virtual	Average sustained speed >= 40 kph.	Time movements started.	Entity state PDU
			Time movements ended.	Entity state PDU
			Distance between start and stop points.	Entity state PDU
			Times/Speeds between firing points.	Entity state PDU
AFAS Mobility Criteria Min. Sustained Speed 4 kph Creep Speed	Live Test, Virtual	Average sustained speed <= 4 kph.	Time minimum speed initiated.	Entity state PDU
			Time minimum speed terminated.	Entity state PDU
			Distance traveled between start and stop.	Entity state PDU
			Type of automotive power used.	Event report PDU
			Engine coolant temperature at start.	Event report PDU
			Engine coolant temperature at stop.	Event report PDU
			Maximum engine temperature during duration.	Event report PDU
			Maximum electric drive temperature between start and stop times if electric drives are used.	Event report PDU
AFAS Mobility Criteria Max Shock to Crew 2.5 G shock over 310 mm half round obstacle at maximum speed.	Live Test, Virtual	Acceleration on crew less than 2.5g	Time positive vertical motion initiated.	X(1).
			Time positive vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
			Time negative vertical motion initiated.	X(1).
			Time negative vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria 2.5 G shock to crew over 410 mm half round obstacle at 16kph.	Live Test, Virtual	Acceleration on crew less than 2.5g	Time positive vertical motion initiated.	X(1).
			Time positive vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
			Time negative vertical motion initiated.	X(1).
			Time negative vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
AFAS Mobility Criteria Tactical Mobility Tactical Speeds West Germany: Dry 24 kph, Wet 18 kph, Snow 20 kph Middle East: Dry 28 kph, Wet 27 kph, Snow 22 kph	Live, Virtual	Average sustained speed >= speeds given in table in first column	Time movements started.	Entity State PDU
			Time movements ended.	Entity State PDU
			Distance between start and stop points.	Entity State PDU
			Times/Speeds between firing points.	Entity State PDU
			Type terrain.	Event report PDU
			Type soil/surface condition.	Event report PDU
AFAS Mobility Criteria Fording 122 cm Max Depth, Hard Bottomed Streams.	Live Test	Vehicle crosses ford at maximum depth (122 cm) without losing directional control	Vehicle displacement when empty. i.e.. will the vehicle float/drift when only a few gallons of fuel remain on-board and everything else is empty.	X(1).
			Velocity of stream/river being crossed.	X(1).
			Lateral slip/drift (if any).	X(1).
AFAS Mobility Criteria Fording Entrance and Exit Slopes of up to 40%	Live Test, Virtual	Vehicle crosses ford without dragging or damaging tube	Distance between banks.	Event report PDUs can report the terrain data carried locally in the host.
			Width of ford.	
			Length of ford.	
		Vehicle enters and exits ford with maximum slopes without losing directional control or taking on water.	Bank height.	
			Minimum ground-tube clearance.	X(1).
			Vehicle Geometry.	X(1).
			Additional approach and departure slopes.	Event report

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Gap Crossing 2.5 meter Capability in the Forward Direction.	Live Test, Virtual	Vehicle crosses without dragging/damaging tube	Vehicle Geometry CG changes with various armament, propellant and fuel loads. Approach and departure slopes. Distance from obstacles that slopes begin and end.	X(1). Event report PDUs can report the terrain data carried locally in the host. Event report PDU Event report PDU
AFAS Mobility Criteria Obstacles 91 cm Vertical Obstacle in the Forward Direction.	Live Test, Virtual	Vehicle crosses without dragging or damaging the tube.	Vehicle Geometry, tube ground clearance. CG changes with armament and fuel loads. Approach and departure slopes. Distance from obstacle that slopes begin/end.	X(1). X(1). Event report PDUs can report the terrain data carried locally in the host. X(1).
AFAS Mobility Criteria Turning Ability 0.7 g Turns on dry pavement at 20% to 100% of vehicle maximum speed.	Live Test	Lateral acceleration on crew less than 0.7g in speed ranges specified.	Time turn started. Speed of vehicle at start and end of turn. Time turn stopped. Radius of turn.	X(1). X(1). X(1). X(1).
AFAS Mobility Criteria Lateral Slope 40% Maximum Lateral Slope Crossing Capability	Live Test	Successfully cross a slope of 40%, perpendicular to the fall line.	Slope crossing capabilities with varying loads and associated centers of gravity. Slope being traversed (in %) Weight of the vehicle. Vehicle Center of Gravity Maximum speed achieved on the slope.	X(1). Event report PDUs can report the terrain data carried locally in the host. Entity state PDU X(1). Entity state PDU

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Longitudinal Slope 60% Maximum Slope Climbing Capability	Live Test	Travel up and down a 60% slope, parallel to the fall line while sustaining a minimum of 5 mph forward velocity.	Slope climbing capabilities with varying loads and associated centers of gravity. Slope being climbed (in %) Weight of the vehicle. Maximum speed achieved on the slope.	X(1). Event report PDUs can report the terrain data carried locally in the host. Entity state PDU X(1).
AFAS Mobility Criteria Hill Speeds Maintain downhill speeds not greater than uphill speeds on long primary road grades of up to 15%. See table below. 2%------65.0 kph 5%------47.4 kph 10%-----32.0 kph 15%-----23.7 kph	Live Test	Maintain a downhill speed that is either equal to or less than the uphill speed of the vehicle without the use of brakes and without the engine overheating.	Average sustained uphill speeds for similar slope. Engine temperature at start and end of slope. Time started down slope. Time arrived at bottom of slope. Engine temperature at bottom of slope.	X(1). X(1). Event report PDU Event report PDU X(1).
AFAS Mobility Criteria Pivot Steer 360 Degree turn within 1.5 times the chassis length.	Live Test, Virtual	360 degree turn completed within a circle with a radius of 1.5 times the vehicle chassis length.	Location of start of turn. Periodic locations during the turn. Location at the end of the turn. Swept area of the tube during the turn. Trafficability in Cities. Mobility in Wooded and constricted terrain.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU X X

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Vehicle Cone Index 26.6 or less for a single pass on fine grained soil.	Live Test	Vehicle crosses soil with RCI >= 26.6 and becomes mired in soil with a RCI of <=26.6.	RCI for soil. Time vehicle entered soft soil area. Time vehicle departed the soft soil area. Minimum speed in the soft soil area. Did the vehicle stop? Trafficability and track footprint. Wheel type and wheel base. Automotive technology: Electrical or Conventional	X(1). Event report PDUs can report the terrain data carried locally in the host. Event report PDU Entity state PDU Event report PDU X(1). X(1). X(1).
AFAS Mobility Criteria Steering Drift 1 meter maximum lateral drift per 30 meters forward travel	Live Test	Vehicle does or does not stop within the lateral limits stated.	Speed of vehicle prior to beginning of braking. Location of vehicle at the beginning of braking. Location of vehicle at the end of braking.	X(1). Entity state PDU X(1). Event report PDU X(1). Entity state PDU
AFAS Mobility Criteria Start and Operate. On all traversable slopes.	Live Test	Vehicle does or does not start on the specified slopes.	Slope at the vehicle's location (in %) Time engine start initiated. Time engine started.	Event report PDU Entity state PDU Entity state PDU
AFAS Mobility Criteria Fuel Economy 15 kg/hr at idle, maximum.	Live Test	Vehicle does or does not attain the required fuel economy under the specified conditions.	Time engine began idling. Time engine stopped idling. Amount of fuel consumed during idling period.	Entity state PDU Entity state PDU X(1).
AFAS Mobility Criteria Unrefueled Range 405 km at 47 mph	Live Test	Vehicle does or does not achieve the specified range under the specified conditions.	Time travel started. Amount of fuel on-board at start. Time travel ended. Distance vehicle traveled.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Refuel Rate 132 liters per minute	Live Test	Vehicle does or does not achieve the specified refueling rate under the specified conditions.	Time refueling started. Time refueling ended. Total number of liters of fuel transferred.	Entity state PDU Entity state PDU Resupply received PDU
AFAS Mobility Criteria Completely refueled within 2 minutes	Live Test	Vehicle does or does not achieve the specified refueling rate under the specified conditions.	Time refueling started. Time refueling ended. Total number of liters of fuel transferred.	Entity state PDU Entity state PDU Entity state PDU
AFAS Mobility Criteria Vehicle Mobility Subsystems: Track and Suspension	Virtual	Vehicle Performance Measurements	Vertical and lateral accelerations on crew and equipment with different type of track and suspension elements Vehicle speed. Obstacle height. Obstacle cross section. Vertical displacement of crew member's CG. Vertical displacement of vehicle's CG	X(1). Event report PDUs could be used for data collection. Entity state PDU X(1). X(1). X(1). X(1).
AFAS Mobility Criteria Vehicle Mobility Subsystems: Propulsion System	Virtual	Vehicle performance with diesel power. Vehicle performance with electric power.	Acceleration. Hill climbing capability Sustained speeds with different types of propulsion systems.	Entity state PDU. Entity state PDU X(1).

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Mobility Criteria Vehicle Subsystems: Auxiliary Power Source	Live, Emulations	Do all critical components remain operational under all normal and abnormal operations.	Test vehicle systems that are electrically powered.	X(1).
			Battery type sources.	X(1).
			Fuel Cell Sources.	X(1).
			Auxiliary Generator Sources.	X(1).
			Commercial Power Sources.	X(1).
			Provide/accept power to/from other vehicles.	X(1).
AFAS Mobility Criteria Vehicle Subsystems: Power Management	Emulations, Virtual	All critical components remain operational under all normal and abnormal operations.	Vary power usage conditions.	X
			Wattage required for full operation.	X(1).
			Wattage required for each electrical component.	X
			Wattage capability of on-board primary and auxiliary power generation systems.	X(1).
			Wattage required for degraded operations.	X
			Determine time spent managing power and applicability of automation	X(1).
Vehicle Subsystems: Interior and Exterior Lighting.	Emulations, Virtual	Is interior and exterior lighting adequate for all operations in each likely crew compartment configuration.	Vary location and intensity of internal and external lighting.	X
			Collect data on crew performance of several different tasks while using each lighting configuration.	X(1).
			Collect data on security compromises under operational conditions with each lighting configuration.	X(1).
Vehicle Subsystems: Upload of Fuel	Live, Emulation	Can fuel be safely uploaded under all normal and abnormal operating conditions.	Collect refueling rates for each of the following *combinations:*	X(1).
			Positive Pressure, Push Fuel;	X
			Negative Pressure Pull Fuel;	X
			Combination	X

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Vehicle Subsystems: Fuel Storage	Live, Emulations	Can fuel be safely stored under all normal and abnormal operating conditions.	Positive Pressure, Push Fuel; Negative Pressure Pull Fuel; Combination	X X X
Vehicle Subsystems: Fuel Handling	Live, Emulations	Can fuel be safely handled under all normal and abnormal operating conditions.	Collect safety data and crew task loading, for each of the following combinations: Positive Pressure, Push Fuel; Negative Pressure, Pull Fuel; Combination Manual upload and download times.	X(1). X X X X(1).
No Spillage	Live, Emulations	Can fuel be transferred without excessive spillage?	Measure spillage, if any, while using the following fuel transfer processes: Positive Pressure, Push Fuel; Measure amount of fuel spilled. Negative Pressure Pull Fuel; Combination Manual processes.	X X X X X X
No Contamination	Live, Emulations	Can fuel be transferred without contaminatio n?	Measure contamination, if any, while using the following fuel transfer processes: Positive Pressure, Push Fuel; Negative Pressure Pull Fuel; Combinations	X X X X

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Vehicle Subsystems: FARV Support and Transport Systems	Virtual	Can the AFAS provide temporary support to the FARV when the FARV is Unable to do so itself.	Can the FARV be attached to the AFAS? Can the AFAS tow the FARV at the required speeds for the required distances? Can the AFAS provide adequate auxiliary power to the FARV to enable the operation of all of the FARV communication systems, NBC protective systems, fuel and ammunition transfer systems and provide adequate power for its own systems.	X X X
AFAS Support and Transport Systems	Live	Can the AFAS provide temporary support to the FARV when the FARV is unable to do so itself.	Can the AFAS be attached to the FARV? Can the AFAS tow the FARV at the required speeds for the required distances? Can the AFAS provide adequate auxiliary power to the FARV to enable the operation of all of the FARV communication systems, NBC protective systems, fuel and ammunition transfer systems and provide adequate power for its own systems.	X X X
Tool Sets	Live		Retrieve, assemble and use tool sets in different configurations and storage	X(1)
Rail Systems	Live		Ability to position the vehicle with different methods and degrees of visibility. Time loading started. Time vehicle in position for tie-down.	X(1) X(1) X(1)
Highway Freight Systems	Live		Ability to position the vehicle with different kinds and degrees of visibility Time loading started. Time vehicle in position for tie-down.	X(1) X(1) X(1)
Sea Transport Systems	Live	Can the vehicle be transported by sea transport.		

Subject of Experimentation/Testing. AFAS Mobility .

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Support and Transport Systems	Live		Ability to provide maintenance support to the AFAS and to be able to tow the AFAS to the maintenance facility.	X(1)
Tool Sets	Live			
Towing Equipment	Live			

X(1). Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.

2. Technical and Operational Benefits of Vehicle Mobility Experimentation in DIS Virtual Environment.

2.1 Stated specifications. Based on the results derived from the above matrix, DIS experimentation appears feasible in assessing the operational and technical tradeoffs in the following AFAS r requirement to keep up with the maneuver forces:

Must keep up with the maneuver forces.
Maximum speeds for the vehicle.
- Sustained speed of 67 kph on hard surfaced roads.
- 39 kph sustained speed cross country.
- 20 kph sustained speed, in reverse, over hard surfaced roads.
- Maintain minimum tactical speeds on uphill and downhill grades of 2% to 60%.
- Braking.

Minimum speeds for the vehicle.
- 4 kph Creep Speed.

Crew environment.
- Maximum of 2.5 G road shock transmitted to crew.
  - •• Maintain maximum speed on 25 mm root mean square terrain.
  - •• Maintain a minimum speed of 64 kph over 38 mm root mean square terrain.
  - •• Maintain a minimum speed of 40 kph over 51 mm root mean square terrain.
  - •• At maximum speed, traversing a 310 mm half round obstacle.
  - •• At 16 kph, traversing a 410 mm half round obstacle.

Terrain Mobility
- Fording: Entrance and Exit Slopes of up to 40%.
- Climbing: 91 cm Vertical Obstacle in the Forward Direction.
- Gap crossing capability of 2.5 meters in the forward direction.
- 40% slope traversing capability.
- 60% slope climbing capability.
- 360 degree turn within a radius of 1.5 times the chassis length.

Vehicle Mobility Subsystems:
- Track and Suspension.
- Propulsion System.
- Auxiliary Power Source.
- Power Management.
- Upload of Fuel.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. The sub-elements listed under paragraph 2.1 can be assessed individually.

Subject of Experimentation/Testing. AFAS Mobility .

1. **Sustained speeds of at least 67 kph over hard surfaced roads.** A set of integrated modules of simulated systems for the AFAS must be developed to support this as well as other tests. The set of modules must include an automotive system consisting of an engine, transmission, final drive unit, sprockets, tracks and track pads or a system consisting of engine, generator, electric traction motors, sprockets, tracks and track pads or hybrids containing components of either system. These modules may already exist, in a library someplace like the Waterways Experiment Station (WES), U.S. Army Corps of Engineers, Geotechnical Laboratory, Analytical Studies Branch. If these modules are developed in software, as objects, they can be reused in other applications. In addition to the automotive system, a suspension system consisting of road wheels, torsion bars, springs, or other electro-mechanical shock absorbing devices. The simulated engine accepts throttle position from the crew cab; fuel type, ambient temperature, etc. from a attribute file; rolling resistance, slope, obstacles, etc. from a terrain file and provides amount power output, excess power available, thermal efficiency, engine temperature, fuel consumption rates, etc. as outputs. The transmission emulation accepts the power output of the engine, subtracts applicable losses and provides the resultant power to the final drives. The final drives accept the power output of the transmission, subtracts losses and provides the resultant power to the sprocket, which turns the tracks, and finally, moves the vehicle. Soil characteristics, vehicle weight and other mechanical losses provide the rolling resistance. If the components are modeled in high fidelity, then the effects of each component can be determined and experimented with to provide the optimum mix of power and suspension that can still meet the criteria to maintain a minimum speed of 67 kph over hard surfaced roads.

2. **Sustained speeds of at least 39 kph over level cross country terrain where the rolling resistance does not exceed 90 kg per tonne of vehicle weight.** The model engine, transmission, final drives, sprockets, tracks, and track pads must be modeled, as described above.

3. **Sustain 20 kph, in reverse, over hard surfaced roads.** The main emphasis of this testing would be to determine what vision and steering devices that the crew/driver need to enable them to keep the vehicle on the road while sustaining the specified speed.

4. **Vehicle Speeds.** Maintain the minimum specified speeds, both in the uphill and the downhill direction. The emphasis of this testing would to determine the specifications for the engine, transmission and brakes that would be needed to satisfy the requirements as well as determine the overall impact on the requirement to keep up with the maneuver force.

5. **Braking.** Decelerate from maximum speed at an average rate of 5 m/s^2 at full combat weight. The emphasis of this testing would to determine the specifications for the engine, transmission and brakes that would be needed to satisfy the requirement.

6. **Vehicle Suspension.** The vehicle suspension must safely carry the vehicle and its crew over terrain of specified roughness at least at the specified speeds without exceeding the vehicle or crew shock limits. The emphasis of the testing would be to determine if the suspension system for the vehicle and crew positions could perform as required for all combinations of vehicle weights, centers of gravity, tactical speeds, size and shapes of obstacles, etc.

7. **Creep Speed.** Sustain a creep speed of 4 kph without engine overheat. Emphasis of this testing is to determine if the automotive system has enough excess cooling capacity to provide adequate cooling while moving at a much slower than normal pace for sustained periods of time. Conducting the experiment in a synthetic environment will allow testing under a wide range of environmental conditions.

8. **AFAS Fording criteria.** The vehicle must be able to ford streams. A major area of interest, other than the simple ability to drive through water that is at or below the specified depth, is how the overhang of the gun tube and its associated pendulum effect, in conjunction with various entrance and exit bank slope configurations and suspension options will affect the fording capability and its associated freedom of cross country movement. Will there be any combinations that cause the tube to drag or dig into the rear bank or slopes while still falling within the fording depth and entrance and exit slope criteria?

9. **AFAS Gap Crossing Criteria.** The vehicle must be able to "self-bridge" small gaps of at least 2.5 meters width, at least while it is traveling in the forward direction. The ability to cross gaps is dependent in part on the center of gravity and the vehicle suspension. Both parameters could be altered incrementally to observe the effects on the requirement each of the variables has on all combinations of operational loads.

10. **Vertical Step/Obstacles.** The vehicle must be able to overcome vertical obstacles. A major area of interest, other than the simple ability to drive over an obstacle, is how the overhang of the gun tube and its associated pendulum effect, in conjunction with various obstacle approach and departure slope configurations and suspension options will affect the vehicle's capability to overcome obstacles and its associated freedom of cross country movement. Will there be any combinations that cause the tube to drag or dig into the rear bank or slopes while still falling within the obstacle height and approach and departure slope criteria?

11. **Vehicle Cornering Ability.** The vehicle must have the capability to make sharp turns at all operational speeds. The ability to accomplish these turns will depend on a combination of total vehicle weight, center of gravity, speed, and vehicle suspension. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of control or overturning?

12. **Slope Crossing and Climbing.**

Subject of Experimentation/Testing. AFAS Mobility .

a. **Cross 40% slope.** The vehicle must have the capability to traverse hard surfaced slopes of up to 40% at all operational speeds. The ability to accomplish traverse these slopes will depend on a combination of total vehicle weight, center of gravity, speed, and vehicle suspension. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of control or overturning.

b. **Climb and descend 60% slopes.** The vehicle must have the ability to climb and descend slopes of up to 60%. The ability to climb and descend these slopes depends on total vehicle weight, center of gravity, suspension and automotive power system. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of power or loss of forward motion.

c. **Start engine and operate on all slopes.** The vehicle must have the ability to start engines on all slopes up to 60%, while facing whether the uphill or downhill. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of engine starting ability on certain slopes.

13. **Pivot Steer Clearances.** An area of interest, other than the simple ability to turn the vehicle in a 360 degree, tight circle, is how the overhang of the gun tube and its associated pendulum effect, in conjunction with various tree densities and stem heights in forests, or city street widths and corners in built-up areas, will affect the maneuvering capability of the vehicle and its associated freedom of movement and choice of routes. What situations will cause the overhang of the main gun tube to be the limiting factor to movement?

14. **Soft Soil Crossing Capability.** With accurate models, the virtual vehicle can try out different combinations of vehicle centers of gravity, automotive power, suspensions and tracks at differing loads and speeds in synthetic operational environments to determine if there will be any unexpected results, like loss of traction or excessive scarring of the soil. Soil and automotive models upon which to build the simulation may already exist at WES.

15. **Unrefueled Range.** With accurate models, the virtual vehicle can try out different combinations of automotive power, suspensions and tracks at differing loads and speeds in synthetic operational environments to determine if there will be any unexpected results in fuel consumption, which in-turn will affect the range of the vehicle.

16. **Refueling Rates.** There are two requirements that must be tested. The first is the vehicle's ability to transfer fuel at a minimum rate of 132 liters per minute. The second is to *transfer the fuel at a rate that will completely refuel the vehicle in two minutes. In operational scenarios,* will these two refueling requirements (a minimum rate and a maximum rate) allow the vehicle to perform continuous operations for a 48 to 96 hours? Under what conditions, i.e. distances between resupply points, vehicle speeds, soil conditions, slopes, number of resupply opportunities, etc. will the minimum or maximum refueling rates be insufficient to maintain the current operational pace.

17. **Track and Suspension Subsystems.** Different suspension models can be mated with chassis to determine if that particular design can meet the operational requirements by performing standard operational scenarios.

18. **Propulsion System.** Different propulsion system models can be mated with chassis and suspension to determine if that particular design can meet the operational requirements by performing standard operational scenarios.

19. **Auxiliary Power Sources.** Different auxiliary power system models can be mated with chassis and suspension to determine if that particular design can meet the operational requirements by performing standard operational scenarios.

20. **Power Management.** Different auxiliary power system models can be employed with different vehicle systems architectures to determine the most useful methods of managing power within the vehicle. Experiment with a range of automation under operational conditions. Experiment with a wide range of possible power sources and their associated short comings, i.e. commercial power and voltage sags and spikes, battery power and low voltage conditions, portable generator power and line noise, etc. Determine the impact of various power sources and their suitability on the accuracy, safety, and reliability of vehicle systems.

21. **Interior and Exterior Lighting.** Use the simulator and/or a virtual vehicle to determine the best locations and types of external and internal lighting. Employ the vehicle in the synthetic environment to determine the operational impacts of having or not having lighting.

2.3 Sample Experiment. The key requirement in the above specifications is for the AFAS to keep up with maneuver forces. Most of the other requirements are enablers that allow the AFAS to meet that one requirement. The ability of the AFAS to keep up with the maneuver force can be evaluated in the DIS environment. Each of the supporting enablers can be varied in-turn to examine its effect on the ability of the AFAS to keep up with the maneuver force. First, create an AFAS full size, functional crew cab and a mathematical model that can represent the rest of the AFAS and its systems. Place the AFAS in a DIS combat scenario. Run the scenario, and monitor the position of the AFAS in relation to the maneuver force. The objective of the experiment is to determine if the AFAS can respond to all requests for fires, conduct rearm as required under all conceivable weather conditions and still maintain the same relative distance from the maneuver forces as it was at the beginning of the scenario, regardless of terrain and number of fire missions received.

Subject of Experimentation/Testing. AFAS Mobility .

1. Place the crew in the crew cab of the AFAS simulator.
2. Place the simulator inside the DES environment.
3. Execute a series of standard scenarios, with the primary variable being the speed of advance of the maneuver force.
4. Have the crew "drive" the AFAS through the synthetic environment, moving as directed by HHQ and responding to calls for fire.
5. Collect data to determine the difference in the distance between the maneuver force and the location of the FAS each time the AFAS receives a call for fire.
6. Vary the synthetic environment and redo the tests using the same scenario. Make the air temperature hotter or colder and see if the automotive system can handle it.
7. Vary the automotive components, the fuel, the rearm times, etc. and see what effects the changes have on the ability of the AFAS to keep up with the maneuver unit.

3. **Required Resources.** To support experimentation and testing in the areas identified above, the following resources are required:

1. One AFAS crew to man an AFAS simulator crew cab.
2. One AFAS crew compartment and associated simulator interfaces, equipped with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area
3. One AFAS emulation system to stimulate the crew interfaces in the simulator and provide, either directly or indirectly, vehicle performance data to the DIS environment. The requirements for the emulator(s) are discussed in more detail in paragraph 4, below.
4. A target acquisition system and fire control to acquire targets and submit calls for fire to engage targets on the virtual battlefield.
5. One fire direction computer operator
6. One AFATDS POC computer to process the observer's call for fire during centralized AFAS operations, automatically relay calls for fire during decentralized operations, and update AFAS information base on fire support coordination measures and battlefield geometry, meteorological data, and preplanned targets.
7. One AFAS SAFOR to support senior to subordinate AFAS operations
8. Threat SAFOR operations order
9. Threat SAFOR to execute the order
10. Friendly force operations order with fire support coordination measures and battlefield geometry
11. Friendly SAFOR to execute the order

4. **Emulators Required.** The following models or emulations will be needed to support the AFAS simulator.

1. Primary automotive emulation packages consisting of models representing an engine/generator and transmission/electric drive unit and final drives/sprockets.
2. Primary chassis and suspension emulation packages consisting of models representing springs/torsion bars, road wheels, tracks and track pads.
3. Chassis model (in software) consisting of chassis, turret, gun tube, crew cab, etc. Primary interest in the DIS testing is in the chassis-gun tube configuration.
4. Auxiliary power system consisting of primary and auxiliary generator, storage batteries, auxiliary hydraulic pump, auxiliary fuel pump, auxiliary propellant pump, materials handling system, etc.

Subject of Experimentation/Testing. AFAS Mobility .

5. Power management system consisting of appropriate power sources, and control devices. Some of the devices may be crew accessible inside the simulator and will require a high fidelity emulation.

Subject of Experimentation/Testing: FARV Mobility Criteria

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria Max Speeds 67 kph Sustained Speed Over Hard Surfaced Roads. 39 kph sustained speed cross country at a rolling resistance of 90 kg/tonne	Live Test, Virtual	Average Sustained Speed >= 67 kph Average sustained cross country speed of 39 kph	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between firing points. Type of suspension system employed Type of automotive system employed. Variables in the Automotive Subsystems.	Entity state PDU Entity state PDU Entity state PDU Event report PDU Event report PDU Event report PDU Event report PDU
FARV Mobility Criteria Max Speeds 20 kph Sustained Speed in Reverse Over Hard Surfaced Roads.	Live Test, Virtual	Average Sustained Speed >= 20 kph	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between firing points. Type of suspension system employed. Type of automotive system employed. Types of Rear Vision Devices	Entity state PDU Entity state PDU Entity state PDU Event report PDU Event report PDU Event report PDU Event report PDU
FARV Mobility Criteria Minimum acceptable speeds on grades of 2% to 60% (as defined below) 2%——65.0 kph 30%——13.5 kph 5%——47.4 kph 40%——9.5 kph 10%——32.0 kph 50%——8.3 kph 15%——23.7 kph 60%——7.0 kph 20%——19.5 kph	Live Test, Virtual	Average Sustained Speed	Time movements started. Ti[illegible]vements ended. Distance between start and stop points.	Entity state PDU Entity state PDU Event report PDU

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Braking	Live Test, Virtual	Average deceleration from maximum speed at 5 m/s^2. at full combat weight. Side drift during stop not to exceed 2 meters in 15 meters of travel. Accomplish 25 consecutive stops at five minute intervals from 80% maximum speed at a rate of 3.3 m/s2 at full combat weight.	Time braking initiated. Speed at time braking initiated. Time vehicle stops. Direction traveling at time braking initiated. Direction traveling when vehicle stopped. Lateral drift distance. Time between full stops. Number of full stops.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU Entity state PDU X(1). /Entity state PDU and Event report PDU. Entity state PDU Entity state PDU
FARV ... bility Criteria Ma... Mu... ...p with the AFAS or the man... ...orces.	Live Test, Virtual	Average distance between the AFAS and the ammunition resupply points.	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between firing points, Distance from AFAS during a battle, at each response to call for resupply.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU Event report PDU
FARV Mobility Criteria Max Speed on 25mm root mean square terrain	Live Test, Virtual	Average Sustained Speed = Maximum Speed	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between rearm and resupply points.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria 64 kph over 38 mm root mean square profile terrain	Live Test, Virtual	Average Sustained Speed >= 64 kph	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between rearm and resupply points. Type of suspension system employed Type of automotive system employed.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU Event report PDU Event report PDU
FARV Mobility Criteria 40 kph over 51mm root mean square profile terrain	Live Test, Virtual	Average Sustained Speed >= 40 kph	Time movements started. Time movements ended. Distance between start and stop points. Times/Speeds between rearm and resupply points. Type of suspension system employed Type of automotive system employed.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU Event report PDU Event report PDU
FARV Mobility Criteria Min. Sustained Speed 4 kph Creep Speed	Live Test, Virtual	Average Sustained Speed >= 4 kph	Time minimum speed initiated. Time minimum speed terminated. Distance traveled between start and stop times. Type of automotive power used. Engine coolant temperature at start Engine coolant temperature at stop Maximum engine temperature during duration. Maximum electric drive temperature between start and stop times if electric drives are used.	Entity state PDU Entity state PDU Entity state PDU Event report PDU Event report PDU Event report PDU Event report PDU Event report PDU.

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria Max Shock to Crew 2.5 G shock to crew over 310 mm half round obstacle at maximum speed.	Live	Acceleration on crew less than 2.5g	Time positive vertical motion initiated.	X(1).
			Time positive vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
			Time negative vertical motion initiated.	X(1).
			Time negative vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
FARV Mobility Criteria Max Shock to Crew 2.5 G shock to crew over 410 mm half round obstacle at 16 kph.	Live	Acceleration on crew less than 2.5g	Time positive vertical motion initiated.	X(1).
			Time positive vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
			Time negative vertical motion initiated.	X(1).
			Time negative vertical motion ceased.	X(1).
			Vertical displacement of crew member's CG.	X(1).
FARV Mobility Criteria Tactical Mobility Tactical Speeds West Germany: Dry 24 kph, Wet 18 kph, Snow 20 kph Middle East: Dry 28 kph, Wet 27 kph, Snow 22 kph	Live, Virtual	Average Sustained Speed as indicated in the table in the first column	Time movements started.	Entity State PDU
			Time movements ended.	Entity State PDU
			Distance between start and stop points.	Entity State PDU
			Times/Speeds between resupply and rearm points.	Entity State PDU
			Type terrain.	Event report PDU
			Type soil/surface condition.	Event report PDU
FARV Mobility Criteria Tactical Mobility Fording 122 cm Max Depth, Hard Bottomed Streams.	Live Test	Vehicle crosses ford at maximum depth without losing directional control	Vehicle displacement when empty. i.e.. will the vehicle float when only a few gallons of fuel remain on-board and everything else is empty.	X(1).
			Velocity of stream/river being crossed.	X(1).
			Lateral slip/drift (if any).	X(1).

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria Tactical Mobility Fording Entrance and Exit Slopes of up to 40%	Live Test	Vehicle enters and exits ford with maximum slopes without losing directional control or taking on water.	Vehicle Geometry. CG changes with armament and fuel loads. Entrance and exit slopes. Distance from edge of the ford that slopes begin/end.	X X Event Report X
FARV Mobility Criteria Tactical Mobility Gap Crossing 2.5 meter Capability in the Forward Direction.	Live Test	Vehicle crosses without becoming trapped or losing directional control.	Vehicle Geometry. CG changes with armament and fuel loads. Approach and departure slopes. Distance from obstacle that slopes begin/end.	X(1). Event report PDUs can report the terrain data carried locally in the host. Event report PDU Event report PDU
FARV Mobility Criteria Tactical Mobility Obstacles 91 cm Vertical Obstacle in the Forward Direction.	Live Test	Vehicle crosses without losing directional control or forward velocity.	Vehicle Geometry. CG changes with armament and fuel loads. Approach and departure slopes. Distance from obstacle that slopes begin/end.	X(1). X(1). Event report PDUs can report the terrain data carried locally in the host. X(1).
FARV Mobility Criteria Tactical Mobility Turning Ability 0.7 g Turns on dry pavement at 20% to 100% of vehicle maximum speed.	Live Test	Lateral acceleration on crew less than 0.7g in speed ranges specified.	Quick turning capabilities with varying loads and associated centers of gravity. Time turn started. Speed of vehicle at start and end of turn. Time turn stopped. Radius of turn.	 X(1). X(1). X(1). X(1).

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria Tactical Mobility Lateral Slope Traversibility 40% Maximum Lateral Slope Crossing Capability	Live Test	Successfully cross a slope of 40%, perpendicular to the fall line.	Slope crossing capabilities with varying loads and associated centers of gravity. Slope being traversed (in %) Weight of the vehicle. Vehicle Center of Gravity Maximum speed achieved on the slope.	X(1). Event report PDUs can report the terrain data carried locally in the host. Entity state PDU X(1). Entity state PDU
FARV Mobility Criteria Tactical Mobility Longitudinal Slope 60% Maximum Slope Climbing Capability	Live Test	Travel up and down a 60% slope, parallel to the fall line while sustaining a minimum of 5 mph forward velocity.	Slope climbing capabilities with varying loads and associated centers of gravity. Slope being climbed (in %) Weight of the vehicle. Maximum speed achieved on the slope.	X(1). Event report PDUs can report the terrain data carried locally in the host. Entity state PDU X(1).
FARV Mobility Criteria Tactical Mobility Longitudinal Slope Downhill Speeds Maintain downhill speeds not greater than uphill speeds on long primary road grades of up to 15%. See table below. 2%-------65.0 kph 5%-------47.4 kph 10%-----32.0 kph 15%-----23.7 kph	Live Test	Maintain a downhill speed that is either equal to or less than the uphill speed of the vehicle without the use of brakes and without the engine overheating.	Average sustained uphill speeds for similar slope. Engine temperature at start and end of slope. Time started down slope. Time arrived at bottom of slope. Engine temperature at bottom of slope.	X(1). X(1). Event report PDU Event report PDU X(1).
FARV Mobility Criteria Tactical Mobility Pivot Steer 360 degree turn within 1.5 times the chassis length.	Live Test	360 degree turn completed within a circle with a radius of 1.5 times the vehicle chassis length.	Location of start of turn. Periodic locations during the turn. Location at the end of the turn. Trafficability in Cities. Mobility in Wooded and constricted terrain.	Entity state PDU Entity state PDU Entity state PDU X X

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria Tactical Mobility Vehicle Cone Index (VCI) 26.6 or less for a single pass on fine grained soil.	Live Test	Vehicle crosses soil with RCI >= 26.6 and becomes mired in soil with a RCI of <=26.6.	RCI for soil. Time vehicle entered soft soil area. Time vehicle departed the soft soil area. Minimum speed in the soft soil area. Did the vehicle stop? Trafficability and track footprint. Wheel type and wheel base. Automotive technology: Electrical or Conventional	X(1). Event report PDUs can report the terrain data carried locally in the host. Event report PDU Entity state PDU X(1). X(1). X(1).
FARV Mobility Criteria Maximum Braking Steering Drift 1 meter lateral drift per 30 meters forward travel at full braking.	Live Test	Vehicle does or does not stop within the lateral limits stated.	Speed of vehicle prior to beginning of braking. Location of vehicle at the beginning of braking. Location of vehicle at the end of braking.	X(1). Entity state PDU X(1). Event report PDU X(1). Entity state PDU
FARV Mobility Criteria Tactical Mobility Start and Operate on all traversable slopes. 60 degrees longitudinal, 40 degrees lateral slopes.	Live Test	Vehicle does or does not start on the specified slopes.	Slope at the vehicle's location (in %) Time engine start initiated. Time engine started.	Event report PDU Entity state PDU Entity state PDU
FARV Mobility Criteria Fuel Economy 15 kg/hr at idle.	Live Test	Vehicle does or does not attain the required fuel economy under the specified conditions.	Time engine began idling. Time engine stopped idling. Amount of fuel consumed during idling period	Entity state PDU Entity state PDU X(1).
FARV Mobility Criteria Fuel Economy Unrefueled Range Minimum acceptable range: 405 km at 47 kph	Live Test	Vehicle does or does not achieve the specified range under the specified conditions.	Time travel started. Amount of fuel on-board at start. Time travel ended. Distance vehicle traveled.	Entity state PDU Entity state PDU Entity state PDU Entity state PDU

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Refuel Rate 132 liters per minute	Live Test	Vehicle does or does not achieve the specified refueling rate under the specified conditions.	Time refueling started. Time refueling ended. Total number of liters of fuel transferred.	Entity state PDU Entity state PDU Resupply received PDU
Refuel Rate Completely refueled within 2 minutes	Live Test	Vehicle does or does not achieve the specified range under the specified conditions.	Time refueling started. Time refueling ended. Total number of liters of fuel transferred.	Entity state PDU Entity state PDU Entity state PDU
FARV Mobility Criteria Vehicle Mobility Subsystems Track and Suspension	Virtual	Vehicle Performance Measurements	Vertical and lateral accelerations on crew and equipment with different type of track and suspension elements Vehicle speed. Obstacle height. Obstacle cross section. Vertical displacement of crew member's CG. Vertical displacement of vehicle's CG	Event response PDU Event response PDU Event response PDU Event response PDU Event response PDU Event response PDU
FARV Mobility Criteria Vehicle Mobility Subsystems Propulsion System	Virtual	Vehicle Performance Measurements Vehicle performance with electric power.	Acceleration. Hill climbing capability Sustained speeds with different types of propulsion systems.	Entity state PDU. Entity state PDU X(1).

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
FARV Mobility Criteria Vehicle Mobility Subsystems Auxiliary Power Source	Virtual	Vehicle does or does not achieve the specified operational capabilities under the specified conditions while power supplied under different operating conditions.	Test vehicle systems that are electrically powered. Battery type sources. Fuel Cell Sources. Auxiliary Generator Sources. Commercial Power Sources. Provide/accept power to/from other vehicles.	X(1). X(1). X(1). X(1). X(1). X(1).
FARV Mobility Criteria Power Management	Virtual	All critical components remain operational under all *normal and* abnormal operations.	Vary power usage conditions. Wattage required for full operation. Wattage required for each electrical component. Wattage capability of on-board primary and auxiliary power generation systems. Wattage required for degraded operations. Determine time spent managing power and applicability of automation	X X(1). X X(1). X X(1).
FARV Mobility Criteria Interior and Exterior Lighting.	Virtual	Is interior and exterior lighting adequate for all operations in each likely crew compartment configuration.	Vary location and intensity of internal and external lighting. Collect data on crew performance of several different tasks while using each lighting configuration. Collect data on security compromises under operational conditions with each lighting configuration.	X X(1). X(1).

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
Upload of Fuel	Virtual	Can fuel be uploaded under all normal and abnormal operating conditions.	Collect refueling rates for each of the following combinations:	X(1).
			Positive Pressure, Push Fuel;	X
			Negative Pressure Pull Fuel;	X
			Combination	X
Fuel Storage	Virtual	Can fuel be safely stored under all normal and abnormal operating conditions.	Collect safety data and crew task loading, for each of the following combinations:	
			Positive Pressure, Push Fuel;	X
			Negative Pressure Pull Fuel;	X
			Combinations	X
Fuel Handling	Virtual	Can fuel be safely handled under all normal and abnormal operating conditions.	Collect safety data and crew task loading, for each of the following combinations:	X(1).
			Positive Pressure, Push Fuel;	X
			Negative Pressure, Pull Fuel;	X
			Combination	X
			Manual upload and download times.	X(1).
No Spillage	Live	Can fuel be transferred without excessive spillage?	Measure spillage, if any, while using the following fuel transfer processes:	X
			Positive Pressure, Push Fuel;	X
			Measure amount of fuel spilled.	X
			Negative Pressure Pull Fuel;	X
			Combination	X
			Manual processes.	X

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
No Contamination	Live	Can fuel be transferred without contaminatio n?	Measure contamination, if any, while using the following fuel transfer processes:	X
			Positive Pressure, Push Fuel;	X
			Negative Pressure Pull Fuel;	X
			Combinations	X
FARV Support and Transport Systems	Live	Can the FARV provide temporary support to the AFAS when the AFAS is unable to do so itself.	Can the AFAS be attached to the FARV?	X
			Can the AFAS tow the FARV at the required speeds for the required distances?	X
			Can the AFAS provide adequate auxiliary power to the FARV to enable the operation of all of the FARV communication systems, NBC protective systems, fuel and ammunition transfer systems and provide adequate power for its own systems.	X
Tool Sets	Live		Retrieve, assemble and use tool sets in different configurations and storage	X(1)
Rail Systems	Live		Ability to position the vehicle with different methods and degrees of visibility.	X(1)
			Time loading started.	X(1)
			Time vehicle in position for tie-down.	X(1)
Highway Freight Systems	Live		Ability to position the vehicle with different kinds and degrees of visibility	X(1)
			Time loading started.	X(1)
			Time vehicle in position for tie-down.	X(1)
Sea Transport Systems	Live	Can the vehicle be transported by sea transport.		

Subject of Experimentation/Testing: FARV Mobility Criteria.

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Insupportable by DIS PDUs)
AFAS Support and Transport Systems	Live		Ability to provide maintenance support to the AFAS and to be able to tow the AFAS to the maintenance facility.	X(1)
Tool Sets	Live			
Towing Equipment	Live			

X(1). **Note: DIS Simulation could provide an appropriate environment for testing and evaluation, however data on the DIS network would not generally support the measurements needed.**

Subject of Experimentation/Testing: FARV Mobility.
2. Technical and Operational Benefits of Vehicle Mobility Experimentation in DIS Virtual Environment.

2.1 Stated specifications. Based on the results derived from the above matrix, DIS experimentation appears feasible in assessing the operational and technical tradeoffs in the following FARV mobility specifications which in-turn support the requirement to keep up with the maneuver forces:

Must keep up with the maneuver forces.

- Maximum speeds for the vehicle.
  - Sustained speed of 67 kph on hard surfaced roads.
  - 39 kph sustained speed cross country.
  - 20 kph sustained speed, in reverse, over hard surfaced roads.
  - Maintain minimum tactical speeds on uphill and downhill grades of 2% to 60%.
  - Braking.
- Minimum speeds for the vehicle.
  - 4 kph Creep Speed.
- Crew environment.
  - Maximum of 2.5 G road shock transmitted to crew.
    - Maintain maximum speed on 25 mm root mean square terrain.
    - Maintain a minimum speed of 64 kph over 38 mm root mean square terrain.
    - Maintain a minimum speed of 40 kph over 51 mm root mean square terrain.
    - At maximum speed, traversing a 310 mm half round obstacle.
    - At 16 kph, traversing a 410 mm half round obstacle.
- Terrain Mobility
  - Fording: Entrance and Exit Slopes of up to 40%.
  - Climbing: 91 cm Vertical Obstacle in the Forward Direction.
  - Gap crossing capability of 2.5 meters in the forward direction.
  - 40% slope traversing capability.
  - 60% slope climbing capability.
  - 360 degree turn within a radius of 1.5 times the chassis length.
- Vehicle Mobility Subsystems:
  - Track and Suspension.
  - Propulsion System.
  - Auxiliary Power Source.
  - Power Management.
  - Upload of Fuel.

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. The sub-elements listed under paragraph 2.1 can be assessed individually.

1. **Sustained speeds of at least 67 kph over hard surfaced roads.** A set of integrated modules of simulated systems for the FARV must be developed to support this as well as other tests. The set of modules must include an automotive system consisting of an engine, transmission, final drive unit, sprockets, tracks and track pads or a system consisting of engine, generator, electric traction motors, sprockets, tracks and track pads or hybrids containing components of either system. These modules may already exist, in a library someplace like the Waterways Experiment Station (WES), U.S. Army Corps of Engineers, Geotechnical Laboratory, Analytical Studies Branch. If these modules are developed in software, as objects, they can be reused in other applications. In addition to the automotive system, a suspension system consisting of road wheels, torsion bars, springs, or other electro-mechanical shock absorbing devices. The simulated engine accepts throttle position from the crew cab; fuel type, ambient temperature, etc. from a attribute file; rolling resistance, slope, obstacles, etc. from a terrain file and provides amount power output, excess power available, thermal efficiency, engine temperature, fuel consumption rates, etc. as outputs. The transmission emulation accepts the power output of the engine, subtracts applicable losses and provides the resultant power to the final drives. The final drives accept the power output of the transmission, subtract losses and provide the resultant power to the sprocket, which turns the tracks and road wheels, and finally moves the vehicle. Soil characteristics, vehicle weight and other mechanical losses provide the rolling resistance. If the components are modeled in high fidelity, then the effects of each component can be determined and experimented with to provide the optimum mix of power and suspension that can still meet the criteria to maintain a minimum speed of 67 kph over hard surfaced roads.

2. **Sustained speeds of at least 39 kph over level cross country terrain where the rolling resistance does not exceed 90 kg per tonne of vehicle weight.** The model engine, transmission, final drives, sprockets, tracks, and track pads must be modeled, as described above.

Subject of Experimentation/Testing: FARV Mobility.

3. **Sustain 20 kph, in reverse, over hard surfaced roads.** The main emphasis of this testing would be to determine what vision and steering devices that the crew/driver need to enable them to keep the vehicle on the road while sustaining the specified speed.

4. **Vehicle Speeds.** Maintain the minimum specified speeds, both in the uphill and the downhill direction. The emphasis of this testing would to determine the specifications for the engine, transmission and brakes that would be needed to satisfy the requirements as well as determine the overall impact on the requirement to keep up with the maneuver force.

5. **Braking.** Decelerate from maximum speed at an average rate of 5 m/s^2 at full combat weight. The emphasis of this testing would to determine the specifications for the engine, transmission and brakes that would be needed to satisfy the requirement.

6. **Vehicle Suspension.** The vehicle suspension must safely carry the vehicle and its crew over terrain of specified roughness at least at the specified speeds without exceeding the vehicle or crew shock limits. The emphasis of the testing would be to determine if the suspension system for the vehicle and crew positions could perform as required for all combinations of vehicle weights, centers of gravity, tactical speeds, size and shapes of obstacles, etc.

7. **Creep Speed.** Sustain a creep speed of 4 kph without engine overheat. Emphasis of this testing is to determine if the automotive system has enough excess cooling capacity to provide adequate cooling while moving at a much slower than normal pace for sustained periods of time. Conducting the experiment in a synthetic environment will allow testing under a wide range of environmental conditions.

8. **FARV Fording criteria.** The vehicle must be able to ford streams. A major area of interest, other than the simple ability to drive through water that is at or below the specified depth, is how the overhang of the gun tube and its associated pendulum effect, in conjunction with various entrance and exit bank slope configurations and suspension options will affect the fording capability and its associated freedom of cross country movement. Will there be any combinations that cause the tube to drag or dig into the rear bank or slopes while still falling within the fording depth and entrance and exit slope criteria.

9. **FARV Gap Crossing Criteria.** The vehicle must be able to "self-bridge" small gaps of at least 2.5 meters width, at least while it is traveling in the forward direction. The ability to cross gaps is dependent in part on the center of gravity and the vehicle suspension. Both parameters could be altered incrementally to observe the effects on the requirement each of the variables has on all combinations of operational loads.

10. **Vertical Step/Obstacles.** The vehicle must be able to overcome vertical obstacles. A major area of interest, other than the simple ability to drive over an obstacle, is how the overhang of the gun tube and its associated pendulum effect, in conjunction with various obstacle approach and departure slope configurations and suspension options will affect the capability to overcome obstacles and its associated freedom of cross country movement. Will there be any combinations that cause the tube to drag or dig into the rear bank or slopes while still falling within the obstacle height and approach and departure slope criteria.

11. **Vehicle Cornering Ability.** The vehicle must have the capability to make sharp turns at all operational speeds. The ability to accomplish these turns will depend on a combination of total vehicle weight, center of gravity, speed, and vehicle suspension. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of control or overturning.

12. **Slope Crossing and Climbing.**

a. Cross 40% slope. The vehicle must have the capability to traverse hard surfaced slopes of up to 40% at all operational speeds. The ability to accomplish traverse these slopes will depend on a combination of total vehicle weight, center of gravity, speed, and vehicle suspension. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of control or overturning.

b. Climb and descend 60% slopes. The vehicle must have the ability to climb and descend slopes of up to 60%. The ability to climb and descend these slopes depends on total vehicle weight, center of gravity, suspension and automotive power system. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of power or loss of forward motion.

c. Start engine and operate on all slopes. The vehicle must have the ability to start engines on all slopes up to 60%, while facing whether the uphill or downhill. With accurate models, the virtual vehicle can try out different combinations of suspensions and combat loads to determine if there will be any unexpected results, like loss of engine starting ability on certain slopes.

13. **Pivot Steer Clearances.** An area of interest, other than the simple ability to turn the vehicle in a 360 degree, tight circle, is how the overhang of the gun tube and its associated pendulum effect, in conjunction with various tree densities and stem heights in forests, or city street widths and corners in built-up areas, will affect the maneuvering capability of the vehicle and its associated freedom of movement and choice of routes. What situations will cause the overhang of the main gun tube to be the limiting factor to movement?

Subject of Experimentation/Testing: FARV Mobility.

14. Soft Soil Crossing Capability. With accurate models, the virtual vehicle can try out different combinations of vehicle centers of gravity, automotive power, suspensions and tracks at differing loads and speeds in synthetic operational environments to determine if there will be any unexpected results, like loss of traction or excessive scarring of the soil. Soil and automotive models upon which to build the simulation may already exist at WES.

15. Unrefueled Range. With accurate models, the virtual vehicle can try out different combinations of automotive power, suspensions and tracks at differing loads and speeds in synthetic operational environments to determine if there will be any unexpected results in fuel consumption, which in-turn will affect the range of the vehicle.

16. Refueling Rates. There are two requirements that must be tested. The first is the vehicle's ability to transfer fuel at a minimum rate of 132 liters per minute. The second is to transfer the fuel at a rate that will completely refuel the vehicle in two minutes. In operational scenarios, will these two refueling requirements (a minimum rate and a maximum rate) allow the vehicle to perform continuous operations for a 48 to 96 hours? Under what conditions, i.e. distances between resupply points, vehicle speeds, soil conditions, slopes, number of resupply opportunities, etc. will the minimum or maximum refueling rates be insufficient to maintain the current operational pace.

17. Track and Suspension Subsystems. Different suspension models can be mated with chassis to determine if that particular design can meet the operational requirements by performing standard operational scenarios.

18. Propulsion System. Different propulsion system models can be mated with chassis and suspension to determine if that particular design can meet the operational requirements by performing standard operational scenarios.

19. Auxiliary Power Sources. Different auxiliary power system models can be mated with chassis and suspension to determine if that particular design can meet the operational requirements by performing standard operational scenarios.

20. Power Management. Different auxiliary power system models can be employed with different vehicle systems architectures to determine the most useful methods of managing power within the vehicle. Experiment with a range of automation under operational conditions. Experiment with a wide range of possible power sources and their associated short comings, i.e. commercial power and voltage sags and spikes, battery power and low voltage conditions, portable generator power and line noise, etc. Determine the impact of various power sources and their suitability on the accuracy, safety, and reliability of vehicle systems.

21. Interior and Exterior Lighting. Use the simulator and/or a virtual vehicle to determine the best locations and types of external and internal lighting. Employ the vehicle in the synthetic environment to determine the operational impacts of having or not having lighting.

2.3 Sample Experiment. The key requirement in the above specifications is for the FARV to keep up with maneuver forces. Most of the other requirements are enablers that allow the FARV to meet that one requirement. The ability of the FARV to keep up with the maneuver force can be evaluated in the DIS environment. Each of the supporting enablers can be varied in-turn to examine its effect on the ability of the FARV to keep up with the maneuver force. First, create an FARV full size, functional crew cab and a mathematical model that can represent the rest of the FARV and its systems. Place the FARV in a DIS combat scenario. Run the scenario, and monitor the position of the FARV in relation to the maneuver force. The objective of the experiment is to determine if the FARV can respond to all requests for fires, conduct rearm as required under all conceivable weather conditions and still maintain the same relative distance from the maneuver forces as it was at the beginning of the scenario, regardless of terrain and number of fire missions received.

1. Place the crew in the crew cab of the FARV simulator.

2. Place the simulator inside the DES environment.

3. Execute a series of standard scenarios, with the primary variable being the speed of advance of the maneuver force.

4. Have the crew "drive" the FARV through the synthetic environment, moving as directed by HHQ and responding to calls for fire.

5. Collect data to determine the difference in the distance between the maneuver force and the location of the FAS each time the FARV receives a call for fire.

6. Vary the synthetic environment and redo the tests using the same scenario. Make the air temperature hotter or colder and see if the automotive system can handle it.

7. Vary the automotive components, the fuel, the rearm times, etc. and see what effects the changes have on the ability of the FARV to keep up with the maneuver unit.

3. Required Resources. To support experimentation and testing in the areas identified above, the following resources are required:

1. One FARV crew to man an FARV simulator crew cab.

Subject of Experimentation/Testing: FARV Mobility.

2. One FARV crew compartment and associated simulator interfaces, equipped with BCC, radios, modems, crew stations, crew displays, supporting software, with access to M712 Copperhead rounds in the ammunition storage area

3. One FARV emulation system to stimulate the crew interfaces in the simulator and provide, either directly or indirectly, vehicle performance data to the DIS environment. The requirements for the emulator(s) are discussed in more detail in paragraph 4, below.

4. A target acquisition system and fire control to acquire targets and submit calls for fire to engage targets on the virtual battlefield.

5. One fire direction computer operator

6. One AFATDS POC computer to process the observer's call for fire during centralized FARV operations, automatically relay calls for fire during decentralized operations, and update FARV information base on fire support coordination measures and battlefield geometry, meteorological data, and preplanned targets.

7. One FARV SAFOR to support senior to subordinate FARV operations

8. Threat SAFOR operations order

9. Threat SAFOR to execute the order

10. Friendly force operations order with fire support coordination measures and battlefield geometry

11. Friendly SAFOR to execute the order

4. **Emulators Required.** The following models or emulations will be needed to support the FARV simulator.

1. Primary automotive emulation packages consisting of models representing an engine/generator and transmission/electric drive unit and final drives/sprockets.

2. Primary chassis and suspension emulation packages consisting of models representing springs/torsion bars, road wheels, tracks and track pads.

3. Chassis model (in software) consisting of chassis, turret, gun tube, crew cab, etc. Primary interest in the DIS testing is in the chassis-gun tube configuration.

4. Auxiliary power system consisting of primary and auxiliary generator, storage batteries, auxiliary hydraulic pump, auxiliary fuel pump, auxiliary propellant pump, materials handling system, etc.

5. Power management system consisting of appropriate power sources, and control devices. Some of the devices may be crew accessible inside the simulator and will require a high fidelity emulation.

Subject of Experimentation/Testing: AFAS Auxiliary Power

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
External Power. The system shall be capable of accepting military and commercial power at worldwide U.S. military facilities for the purpose of conducting training and maintenance activities. These activities shall include starting the main engine, running diagnostic routines, downloading ammunition and supporting embedded training functions.	Live	Total quantity of main engine fuel consumed, with and without external power Comparative percentage of engine down time, with and without external power		
Reduced power mode. The system shall be capable of supporting all functions (less firing the primary armament, operating the NBC collective protection system, or moving the vehicle) for a period of time no less than 6 hours. If this capability is provided external to the main engine, it shall be capable of starting the main engine. The system shall be able to transition from this mode to full operational status within 45 seconds.	Virtual or Live	Total quantity of main engine fuel consumed per hour, with and without auxiliary power Comparative percentage of engine down time, with and without auxiliary power	Quantity of fuel on board at time "t" Main engine status at time "t" Full operational status (y/n) at time "t" Time transition to full *operational status* started	Data PDU Entity state PDU Event report PDU *Event report PDU*

Subject of Experimentation/Testing: AFAS Auxiliary Power

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** The benefits of this kind of experimentation are limited to providing a small input to a broader evaluation of the system fuel consumption, maintenance and resupply requirements.

3. **Required Resources.** DIS PDUs to capture fuel consumption and maintenance down time.

Subject of Experimentation/Testing: FARV Auxiliary Power

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified or New DIS PDUs Required to Collect Data Elements (X=Unsupportable by DIS PDUs)
External Power. The system shall be capable of accepting military and commercial power at worldwide U.S. military facilities for the purpose of conducting training and maintenance activities. These activities shall include starting the main engine, running diagnostic routines, downloading ammunition and supporting embedded training functions.	Live	Total quantity of main engine fuel consumed, with and without external power Comparative percentage of engine down time, with and without external power		
Reduced power mode. The system shall be capable of supporting all functions (less firing the primary armament, operating the NBC collective protection system, or moving the vehicle) for a period of time no less than 6 hours. If this capability is provided external to the main engine, it shall be capable of starting the main engine. The system shall be able to transition from this mode to full operational status within 45 seconds.	Virtual or Live	Total quantity of main engine fuel consumed, with and without auxiliary power Comparative percentage of engine down time, with and without auxiliary power	Quantity of fuel on board at time "t" Main engine status at time "t" Full operational status (y/n) at time "t" Time transition to full operational status started	Data PDU Entity state PDU Event report PDU Event report PDU

Subject of Experimentation/Testing: FARV Auxiliary Power

2. **Technical and Operational Benefits of Experimentation in DIS Virtual Environment.** The benefits of this kind of experimentation are limited to providing a small input to a broader evaluation of the system fuel consumption, maintenance and resupply requirements.

3. **Required Resources.** DIS PDUs to capture fuel consumption and maintenance down time.

Subject of Experimentation/Testing: AFAS Interoperability

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. The C3 Subsystem shall use Single Channel Ground and Airborne Radio System (SINCGARS) AN/VRC-92A (long range receiver/transmitters (R/T) combat net radio for voice and data communications. One R/T will be dedicated to voice and the other to data communications.	Live or Virtual		Capability	
			Record of digital message traffic over SINCGARS radios	Transmitter, Receiver and Signal PDUs
			Record of voice communications over SINCGARS radios	Transmitter, Receiver and Signal PDUs
Message Compatibility. All messages shall be compatible with the Advanced Field Artillery Tactical Data System (AFATDS) using protocols specified in MIL-STD 188-200/V/M and FATDS Version 10.	Live or Virtual		Accuracy	
		Percent of errors in AFATDS messages	Number of AFAS messages by type transmitted to AFATDS configured systems	Transmitter, Receiver and Signal PDUs
			Number of AFAS messages by type received to AFATDS configured systems	Transmitter, Receiver and Signal PDUs
			Record of AFATDS message errors	Transmitter, Receiver and Signal PDUs
		Percent of errors in FATDS messages	Number of AFAS messages by type transmitted to FATDS configured systems	Transmitter, Receiver and Signal PDUs
			Number of AFAS messages by type received to FATDS configured systems	Transmitter, Receiver and Signal PDUs
			Record of FATDS message errors	Transmitter, Receiver and Signal PDUs

Subject of Experimentation/Testing: AFAS Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
FARV Interoperability. The AFAS is supported by the FARV which provides for automated fuel and ammunition resupply and manual resupply of other consumables.	Live or Virtual		**Capability**	
			Record of dockings between FARV and AFAS	Event Report PDU
			Record of Interoperability problems	X
			Record of manual resupply items requested by AFAS	Signal PDU
			Record of manual resupply items delivered by FARV	Signal PDU
		Percent of successful dockings	Number of dockings and transfers attempted	Event Report PDU
			Number of dockings and transfers successfully completed	Event Report PDU
			Accuracy	
		Percent accuracy of fuel exchange	Quantity of fuel requested by AFAS	Signal or Event Report PDU
			Quantity of fuel delivered by FARV	Signal or Event Report PDU
		Percent accuracy of LP propellant exchange	Quantity of LP propellant requested by AFAS	Signal or Event Report PDU
			Quantity of LP propellant delivered by FARV	Signal or Event Report PDU
		Percent accuracy of ammunition exchange	Quantity of ammunition requested by AFAS	Signal or Event Report PDU
			Quantity of ammunition delivered by FARV	Signal or Event Report PDU
		Percent accuracy of resupply data exchange	Number of fuzed projectiles by lot, fuze, type and weight transferred by sending system	Signal PDU
			Number of fuzed projectiles by lot, fuze, type and weight accepted by receiving system	Event Report PDU
DIS Interoperability. The system will include a network interface compatible with Distributive Interactive Simulation (DIS) protocols and standards.	Live or SIL		**Capability**	
		Percent accurate PDUs generated	Record of DIS PDU generated without error	All PDUs generated can be captured via dataloggers for analysis.
			Record of DIS PDUs generated	
The interface shall consist of a DIS Cell Interface Unit (CIU) or a DIS Cell Adapter Unit (CAU) as defined by the DIS Architecture Description Document.			Record of operations with conducted DIS CAU	
			Record of operations conducted with DIS CIU	

Subject of Experimentation/Testing: AFAS Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Docking Interface. The system shall have a physical interface with the FARV. The interface shall include a power interface, an ammunition transfer interface, a fuel transfer interface, and a communications interface.	Live or Virtual		**Capability** Record of fuel transfers completed through docking interface Record of voice and digital communications conducted through the docking interface Record of ammunition transfers conducted through the docking interface	 Signal PDU Signal PDU Signal PDU
Intervehicle C3. The C3 system shall be interoperable with FARV to execute its intended mission.	Live or Virtual		**Capability** Record of digital communications between vehicles when docked Record of voice communications between vehicles when docked	 Signal PDU Signal PDU
Fuel Interoperability. The AFAS shall be capable of being manually refueled from standard Army on-vehicle fuel containers and from standard Army refueling vehicles. The system shall also have a NATO standard fuel interface. The system shall be compatible with Standard Army Refueling System (SARS).	Live or Virtual	Median Manual Fuel Transfer Time	**Capability** Record of manual fuel transfer operations Type of refueling vehicle Record of problems during refueling operations **Time** Time fuel transfer stopped Time fuel transfer started	 X X X Event Report PDU Event Report PDU

Subject of Experimentation/Testing: AFAS Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Power Interoperability. The AFAS shall be capable of accepting military and commercial power at worldwide U.S. military facilities for the purpose of conducting training and maintenance activities including starting the main engine, running diagnostic routines, downloading ammunition and supporting embedded training functions.	Live or Virtual		**Capability** Record of engine starts from external power Record of diagnostics run from external power Record of ammunition downloads operations conducted with external power Record of supporting embedded training operations conducted with external power Source of external power (Military, civilian, FARV, AFAS, etc.)	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The system shall be capable of accepting power from the FARV.			**Capability** Record of engine starts where FARV provided external power Record of diagnostics run where FARV provided external power Record of ammunition downloads operations conducted where FARV provided external power	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The system shall be capable of being started with the standard NATO military power transfer slave cable (dwg 11682345, MIL-S-52131 and MIL-C-62122).			**Capability** Record of engine starts with the standard NATO military power transfer slave cable	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
Ground Transportability. The AFAS shall be transportable by military and commercial Heavy Equipment Transporters (HET).	Live or Virtual		**Capability** Record of loading on a Heavy Equipment Transporters (HET) Type of HET (military or commercial) Problems encountered with HET loading	X X X
Air Transportability. The AFAS shall be air transportable by C-5 and C-17 aircraft in an operational configuration (non-sectionalized).	Live or Virtual		**Capability** Record of loading on a USAF aircraft Type of aircraft (C-5 or C-17) Problems encountered with aircraft loading	X X X
Rail Transportability. The AFAS shall be transportable by rail and comply with the NATO envelope B rail equipment	Live or Virtual		**Capability** Record of loading on rail cars Type of car (US or NATO) Problems encountered with rail loading	X X X

Subject of Experimentation/Testing: AFAS Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Sea Transportability. The AFAS shall be transportable by break bulk freighter, container ships (as deck cargo), roll-on, roll-off (RORO) vessels, lighter-aboard-ship (LASH), sea-barge (SEABEE) carrier and the U.S. Army Tactical Watercraft Fleet (LARC-LX and larger vessels) operating in sea state 7.	Live or Virtual		**Capability** Record of loading on a ship Type of ship (break bulk freighter, container ships (as deck cargo), roll-on, roll-off (RORO) vessels, lighter-aboard-ship (LASH), sea-barge (SEABEE) carrier and the U.S. Army Tactical Watercraft Fleet (LARC-LX and larger vessels)) Problems encountered with ship loading Sea state conditions (1 through 10)	 X X X X
Semi-Automated Forces (SAF). Semi-Automated Forces (SAF) implementation shall include battlefield entities required as a result of adding AFAS to the electronic battlefield, including the AFAS system itself.	Virtual		**Capability** Record of AFAS SAFOR Record of SAFOR encountered during exercises by the AFAS simulator or SAFOR Record of PDUs received by AFAS Record of PDUs sent by the AFAS	
Digital Mapping Technology Interoperability. The AFAS graphical display shall use digital map data bases available as standard products from the Defense Mapping Agency and provide for: - checks for intermediate crest clearance - vertical interval - location in northing, Easting and altitude - uses conventions of the Universal Transverse Mercator (UTM) coordinate system	Live or Virtual		**Capability** Record of DMA digital map data bases used **Accuracy**	
		Percent agreement of crest clearance	DMA indicated intermediate crest clearance Measured intermediate crest clearance	Event Report PDU Event Report PDU
		Percent agreement of vertical interval	DMA indicated vertical interval Measured vertical interval	Event Report PDU Event Report PDU
		Percent agreement of position	DMA indicated position (UTM Easting, Northing and Altitude) Measured position (UTM Easting, Northing and Altitude)	Event Report PDU Event Report PDU
IFF Interoperability. The AFAS shall use standard Battlefield Combat Identification System procedures and equipment to reduce the potential for fratricide.	Live or Virtual		**Capability** Record of BCIS use Problems encountered with IFF identification	 Event Report PDU X

Subject of Experimentation/Testing: AFAS Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Field Artillery Interoperability. The AFAS shall be capable of operating with other U.S. Army Field Artillery systems including: - AN/TPQ-36 Radar - AN/TPQ -37 Radar - MBC-23 - FARV - AFAS - FIST DMD - DMD - Battery Computer System (BCS) - Battalion Tactical Fire Direction System (BN TACFIRE) - Brigade, Corps, Division Tactical Fire Direction System (BCD TACFIRE)	Live or Virtual	Percent of incoming messages translated without error Percent of outgoing messages translated without error	**Completeness** Number of messages received by the AFAS Number of messages properly acknowledged (ACK) Number of messages not acknowledged (NAK) Originator of message Number of messages sent by the system Number of messages properly acknowledged (ACK) by the receiver Number of messages not acknowledged (NAK) by the receiver Destination of message	Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: AFAS Interoperability

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow evaluation of the tactics, techniques and procedures and key operational capabilities available to support and determine AFAS battlefield interoperability. The AFAS as a component of the "system of systems - the Field Artillery" must be able to interoperate with other vehicle and systems on the battlefield to effectively and efficiently complete its mission. The system could be looked at for integration of various levels of automation, expert (decision aids) systems and controls/displays and their impact on the operational effectiveness on the battlefield. Assessment of the adequacy, maturity and compatibility of AFAS capabilities could be made. Selection and development of new or revised tactics, techniques and procedures could be pursued. Validation of the AFAS's ability to operate with and be transported by a number of service assets validates its deployability and transportability. Operation with the software of other FA systems and vehicles, including the FARV, demonstrates the system's ability to operate within the FA digital communications network. From the technical perspective, communicating to other systems demonstrates the AFAS system interfaces with those systems.

2.1 Stated specifications:

- Communications
- Message Compatibility
- FARV Interoperability
- Intervehicle C3
- DIS Interoperability
- Docking Interface
- Fuel Interoperability
- Power Interoperability
- Ground Transportability
- Air Transportability
- Rail Transportability
- Sea Transportability
- Semi Automated Forces (SAF)
- Digital Mapping Technology Interoperability
- IFF Interoperability
- Field Artillery Interoperability

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 **Sample Experiment.** A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the AFAS System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains deployment to an overseas area, the AFAS could be shipped by aircraft or ship, transported on a US rail system to the embarkation point and NATO B rail system from the debarkation point, and finally by ground transportation by HET to the forward area. This sequence of events could evaluate the overall impact on system and crew's capability to meet battlefield, system and transportability requirements. Placing the AFAS simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the AFAS specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Median times of rearm/resupply/refuel operations
- Average rate of rearm/resupply/refuel operations
- Accuracy of rearm/resupply/refuel operations, both manual and automated
- Median Times required to conduct LRP Operations
- Compatibility with Ammunition types and sizes
- Demonstrated compatibility with AFATDS hardware and software
- Demonstrated compatibility with FATDS Version 10 hardware and software
- Demonstrated compatibility with ATCCS common hardware and software
- Number of missions completed
- Number and type of rearm/resupply/refuel operations conducted

Subject of Experimentation/Testing: AFAS Interoperability

- Number and types of projectile/fuze combinations resupplied
- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to combat operations
- Communications net loading both digital and voice networks
- Number and type of manual rearm/resupply/refuel operations conducted
- Operations conducted at the approved Operational Mode Summary/Mission Profile (OMS/MP)

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One AFAS crew to man an AFAS simulator
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software
- One FARV SAFOR to support AFAS to FARV resupply/rearm/refuel, communications and docking operations
- One SAFOR PLS Truck to support LRP Operations
- One SAFOR fuel truck to support LRP refueling operations
- A Time Ordered Events List (TOEL)
- ATCCS common hardware and software
- Various FA tactical systems and associated FATDS software for communications interoperability
- Various FA tactical systems and associated AFATDS software for communications interoperability
- Equipment to support transportability assessments (NATO B rail car, US rail car, HET (military), HET (commercial), C-5, C-17, break bulk freighter, container ships, roll-on, roll-off (RORO) vessels, lighter-aboard-ship (LASH), sea-barge (SEABEE) carrier and the U.S. Army Tactical Watercraft Fleet (LARC-LX and larger vessels)

Subject of Experimentation/Testing: FARV Interoperability

1. Data Collection Requirements

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Communications. The C3 Subsystem shall use Single Channel Ground and Airborne Radio System (SINCGARS) AN/VRC-92A (long range receiver/transmitters (R/T) combat net radio for voice and data communications. One R/T will be dedicated to voice and the other to data communications.	Live or Virtual		Capability	
			Record of digital message traffic over SINCGARS radios	Transmitter, Receiver and Signal PDUs
			Record of voice communications over SINCGARS radios	Transmitter, Receiver and Signal PDUs
Compatibility. All messages shall be compatible with the Advanced Field Artillery Tactical Data System (AFATDS).	Live or Virtual		Accuracy	
		Percent of errors in AFATDS messages	Number of AFAS messages by type transmitted to AFATDS configured systems	Transmitter, Receiver and Signal PDUs
			Number of AFAS messages by type received to AFATDS configured systems	Transmitter, Receiver and Signal PDUs
			Record of AFATDS message errors	Transmitter, Receiver and Signal PDUs
		Percent of errors in FATDS messages	Number of AFAS messages by type transmitted to FATDS configured systems	Transmitter, Receiver and Signal PDUs
			Number of AFAS messages by type received to FATDS configured systems	Transmitter, Receiver and Signal PDUs
			Record of FATDS message errors	Transmitter, Receiver and Signal PDUs

Subject of Experimentation/Testing: FARV Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
AFAS Interoperability. The AFAS is supported by the FARV which provides for automated fuel and ammunition resupply and manual resupply of other consumables.	Live or Virtual		**Capability**	
			Record of dockings between FARV and AFAS	Event Report PDU
			Record of Interoperability problems	X
			Record of manual resupply items requested by AFAS	Signal PDU
			Record of manual resupply items delivered by FARV	Signal PDU
		Percent of successful dockings	Number of dockings and transfers attempted	Event Report PDU
			Number of dockings and transfers successfully completed	Event Report PDU
			Accuracy	
		Percent accuracy of fuel exchange	Quantity of fuel requested by AFAS	Signal or Event Report PDU
			Quantity of fuel delivered by FARV	Signal or Event Report PDU
		Percent accuracy of LP propellant exchange	Quantity of LP propellant requested by AFAS	Signal or Event Report PDU
			Quantity of LP propellant delivered by FARV	Signal or Event Report PDU
		Percent accuracy of ammunition exchange	Quantity of ammunition requested by AFAS	Signal or Event Report PDU
			Quantity of ammunition delivered by FARV	Signal or Event Report PDU
		Percent accuracy of resupply data exchange	Number of fuzed projectiles by lot, fuze, type and weight transferred by sending system	Signal PDU
			Number of fuzed projectiles by lot, fuze, type and weight accepted by receiving system	Event Report PDU
DIS Interoperability. The system will include a network interface compatible with Distributive Interactive Simulation (DIS) protocols and standards.	Live or SIL		**Capability**	
		Percent accurate PDUs generated	Record of DIS PDU generated without error	All PDUs generated can be captured via dataloggers for analysis.
			Record of DIS PDUs generated	
The interface shall consist of a DIS Cell Interface Unit (CIU) or a DIS Cell Adapter Unit (CAU) as defined by the DIS Architecture Description Document.			Record of operations with conducted DIS CAU	
			Record of operations conducted with DIS CIU	

Subject of Experimentation/Testing: FARV Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Docking Interface. The system shall have a physical interface with AFASs. The interface shall include a power interface, an ammunition transfer interface, a fuel transfer interface, and a communications interface.	Live or Virtual		**Capability**	
			Record of fuel transfers completed through docking interface	Signal PDU
			Record of voice and digital communications conducted through the docking interface	Signal PDU
			Record of ammunition transfers conducted through the docking interface	Signal PDU
Intervehicle C3. The C3 system shall be interoperable with AFAS to execute its intended mission.	Live or Virtual		**Capability**	
			Record of digital communications between vehicles when docked	Signal PDU
			Record of voice communications between vehicles when docked	Signal PDU
Fuel Interoperability. The FARV shall be capable of being manually refueled from standard Army on-vehicle fuel containers and from standard Army refueling vehicles. The system shall also have a NATO standard fuel interface. The system shall be compatible with Standard Army Refueling System (SARS).	Live or Virtual		**Capability**	
			Record of manual fuel transfer operations	X
			Type of refueling vehicle	X
			Record of problems during refueling operations	X
			Time	
		Median Manual Fuel Transfer Time	Time fuel *transfer stopped*	Event Report PDU
			Time fuel transfer started	Event Report PDU

Subject of Experimentation/Testing: FARV Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Power Interoperability. The FARV shall be capable of accepting military and commercial power at worldwide U.S. military facilities for the purpose of conducting training and maintenance activities including starting the main engine, running diagnostic routines, downloading ammunition and supporting embedded training functions.	Live or Virtual		**Capability** Record of engine starts from external power Record of diagnostics run from external power Record of ammunition downloads operations conducted with external power Record of supporting embedded training operations conducted with external power Source of external power (Military, civilian, FARV, AFAS, etc.)	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The system shall be capable of accepting power from the AFAS.			**Capability** Record of engine starts where AFAS provided external power Record of diagnostics run where AFAS provided external power Record of ammunition downloads operations conducted where AFAS provided external power	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
The system shall be capable of being started with the standard NATO military power transfer slave cable (dwg 11682345, MIL-S-52131 and MIL-C-62122).			**Capability** Record of engine starts with the standard NATO military power transfer slave cable	X (Generally, these data elements are not available in the normal DIS PDU stream. However, they could be made available through custom Event Report PDUs.)
Ground Transportability. The FARV shall be transportable by military and commercial Heavy Equipment Transporters (HET).	Live or Virtual		**Capability** Record of loading on a Heavy Equipment Transporters (HET) Type of HET (military or commercial) Problems encountered with HET loading	 X X X
Air Transportability. The FARV shall be air transportable by C-5 and C-17 aircraft in an operational configuration (non-sectionalized).	Live or Virtual		**Capability** Record of loading on a USAF aircraft Type of aircraft (C-5 or C-17) Problems encountered with aircraft loading	 X X X
Rail Transportability. The FARV shall be transportable by rail and comply with the *NATO envelope B rail equipment*	Live or Virtual		**Capability** Record of loading on rail cars Type of car (US or NATO) Problems encountered with rail loading	 X X X

Subject of Experimentation/Testing: FARV Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Sea Transportability. The FARV shall be transportable by break bulk freighter, container ships (as deck cargo), roll-on, roll-off (RORO) vessels, lighter-aboard-ship (LASH), sea-barge (SEABEE) carrier and the U.S. Army Tactical Watercraft Fleet (LARC-LX and larger vessels) operating in sea state 7.	Live or Virtual		**Capability** Record of loading on a ship Type of ship (break bulk freighter, container ships (as deck cargo), roll-on, roll-off (RORO) vessels, lighter-aboard-ship (LASH), sea-barge (SEABEE) carrier and the U.S. Army Tactical Watercraft Fleet (LARC-LX and larger vessels)) Problems encountered with ship loading Sea state conditions (1 through 10)	 X X X X
Semi-Automated Forces (SAF). Semi-Automated Forces (SAF) implementation shall include battlefield entities required as a result of adding FARV to the electronic battlefield, including the FARV system itself.	Virtual		**Capability** Record of FARV SAFOR Record of SAFOR encountered during exercises by the FARV simulator or SAFOR Record of PDUs received by FARV Record of PDUs sent by the FARV	
Digital Mapping Technology Interoperability. The FARV graphical display shall use digital map data bases available as standard products from the Defense Mapping Agency and provide for: - vertical interval - location in northing, Easting and altitude - uses conventions of the Universal Transverse Mercator (UTM) coordinate system	Live or Virtual	Percent agreement of vertical interval Percent agreement of position	**Capability** Record of DMA digital map data bases used **Accuracy** DMA indicated vertical interval Measured vertical interval DMA indicated position (UTM Easting, Northing and Altitude) Measured position (UTM Easting, Northing and Altitude)	Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU Event Report PDU
IFF Interoperability. The FARV shall use standard Battlefield Combat Identification System procedures and equipment to reduce the potential for fratricide.	Live or Virtual		**Capability** Record of BCIS use Problems encountered with IFF identification	 Event Report PDU X

Subject of Experimentation/Testing: FARV Interoperability

Specifications	Environments for Testing/ Experimentation	Measures of Performance	Characteristics and Their Data Elements for Collection if DIS Virtual Simulation is Appropriate Environment	Existing, Modified, or New DIS PDUs Required to Collect Data Elements (X = Unsupportable by DIS PDUs)
Field Artillery Interoperability. The FARV shall be capable of operating with other U.S. Army Field Artillery systems including: - AN/TPQ-36 Radar - AN/TPQ -37 Radar - MBC-23 - FARV - AFAS - FIST DMD - DMD - Battery Computer System (BCS) - Battalion Tactical Fire Direction System (BN TACFIRE) - Brigade, Corps, Division Tactical Fire Direction System (BCD TACFIRE)	Live or Virtual	Percent of incoming messages translated without error Percent of outgoing messages translated without error	**Completeness** Number of messages received by the FARV Number of messages properly acknowledged (ACK) Number of messages not acknowledged (NAK) Originator of message Number of messages sent by the system Number of messages properly acknowledged (ACK) by the receiver Number of messages not acknowledged (NAK) by the receiver Destination of message	 Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU Signal PDU

Subject of Experimentation/Testing: FARV Interoperability

2. Technical and Operational Benefits of Experimentation in DIS Virtual Environment. A DIS Virtual Environment would allow evaluation of the tactics, techniques and procedures and key operational capabilities available to support and determine FARV battlefield interoperability. The AFAS as a component of the "system of systems - the Field Artillery" must be able to interoperate with other vehicle and systems on the battlefield to effectively and efficiently complete its mission. The system could be looked at for integration of various levels of automation, expert (decision aids) systems and controls/displays and their impact on the operational effectiveness on the battlefield. Assessment of the adequacy, maturity and compatibility of FARV capabilities could be made. Selection and development of new or revised tactics, techniques and procedures could be pursued. Validation of the FARV's ability to operate with and be transported by a number of service assets validates its deployability and transportability. Operation with the software of other FA systems and vehicles, including the AFAS, demonstrates the system's ability to operate within the FA digital communications network. From the technical perspective, communicating to other systems demonstrates the FARV system interfaces with those systems.

2.1 Stated specifications:

- Communications
- Compatibility
- AFAS Interoperability
- Intervehicle C3
- DIS Interoperability
- Docking Interface
- Fuel Interoperability
- Power Interoperability
- Ground Transportability
- Air Transportability
- Rail Transportability
- Sea Transportability
- Semi Automated Forces (SAF)
- Digital Mapping Technology Interoperability
- IFF Interoperability
- Field Artillery Interoperability

2.2 Other Aspects of Performance Measurable in a DIS Virtual Environment. None

2.3 Sample Experiment. A single experiment/scenario in the DIS virtual environment can address each of the specifications and other aspects of performance outlined above. Analysts and testers can run the same experiment repeatedly altering or invoking system capabilities. The experiments should be run against approved Training and Doctrine Command (TRADOC) scenarios appropriate to the FARV System Threat Assessment Report (STAR) and at combat tempo in accordance with the approved Operational Mode Summary/Mission Profile (OMS/MP). For example if the scenario contains deployment to an overseas area, the AFAS could be shipped by aircraft or ship, transported on a US rail system to the embarkation point and NATO B rail system from the debarkation point, and finally by ground transportation by HET to the forward area. This sequence of events could evaluate the overall impact on system and crew's capability to meet battlefield, system and transportability requirements. Placing the FARV simulator on a combined arms virtual battlefield may not permit validations of some aspects as specified in the FARV specification. However, the overall impact of design capabilities can be measured in terms of the battle outcomes at the conclusion of the experiment/scenario. Listed below are example battle statistics and conclusions that testers/analysts may derive from the data elements in the above matrix to correlate experiment results to design capabilities and/or changes:

- Median times of rearm/resupply/refuel operations
- Average rate of rearm/resupply/refuel operations
- Accuracy of rearm/resupply/refuel operations, both manual and automated
- Median Times required to conduct LRP Operations
- Compatibility with Ammunition types and sizes
- Demonstrated compatibility with AFATDS hardware and software
- Demonstrated compatibility with FATDS Version 10 hardware and software
- Demonstrated compatibility with ATCCS common hardware and software
- Number of missions completed
- Number and type of rearm/resupply/refuel operations conducted
- Number and types of projectile/fuze combinations resupplied

Subject of Experimentation/Testing: FARV Interoperability

- Number and type of resupply operations conducted with Decision Aids
- Number and type of resupply operations conducted without Decision Aids
- Accuracy and quantity of messages by type related to combat operations
- Communications net loading both digital and voice networks
- Number and type of manual rearm/resupply/refuel operations conducted
- Operations conducted at the approved Operational Mode Summary/Mission Profile (OMS/MP)

3. **Required Resources.** To support experimentation and testing in the areas identified above the following resources are required:

- One FARV crew to man an FARV simulator
- One FARV simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software
- One AFAS simulator equipped with BCC, radios, modems, crew stations, crew displays, supporting software to conduct fire missions
- One AFAS SAFOR to support AFAS to FARV resupply/rearm/refuel, communications and docking operations
- One SAFOR PLS Truck to support LRP Operations
- One SAFOR fuel truck to support LRP refueling operations
- A Time Ordered Events List (TOEL)
- ATCCS common hardware and software
- Various FA tactical systems and associated FATDS software for communications interoperability
- Various FA tactical systems and associated AFATDS software for communications interoperability
- Equipment to support transportability assessments (NATO B rail car, US rail car, HET (military), HET (commercial), C-5, C-17, break bulk freighter, container ships, roll-on, roll-off (RORO) vessels, lighter-aboard-ship (LASH), sea-barge (SEABEE) carrier and the U.S. Army Tactical Watercraft Fleet (LARC-LX and larger vessels)